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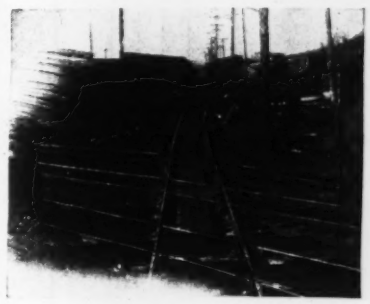

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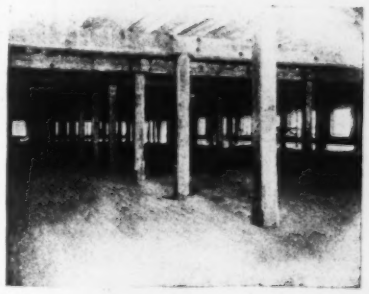

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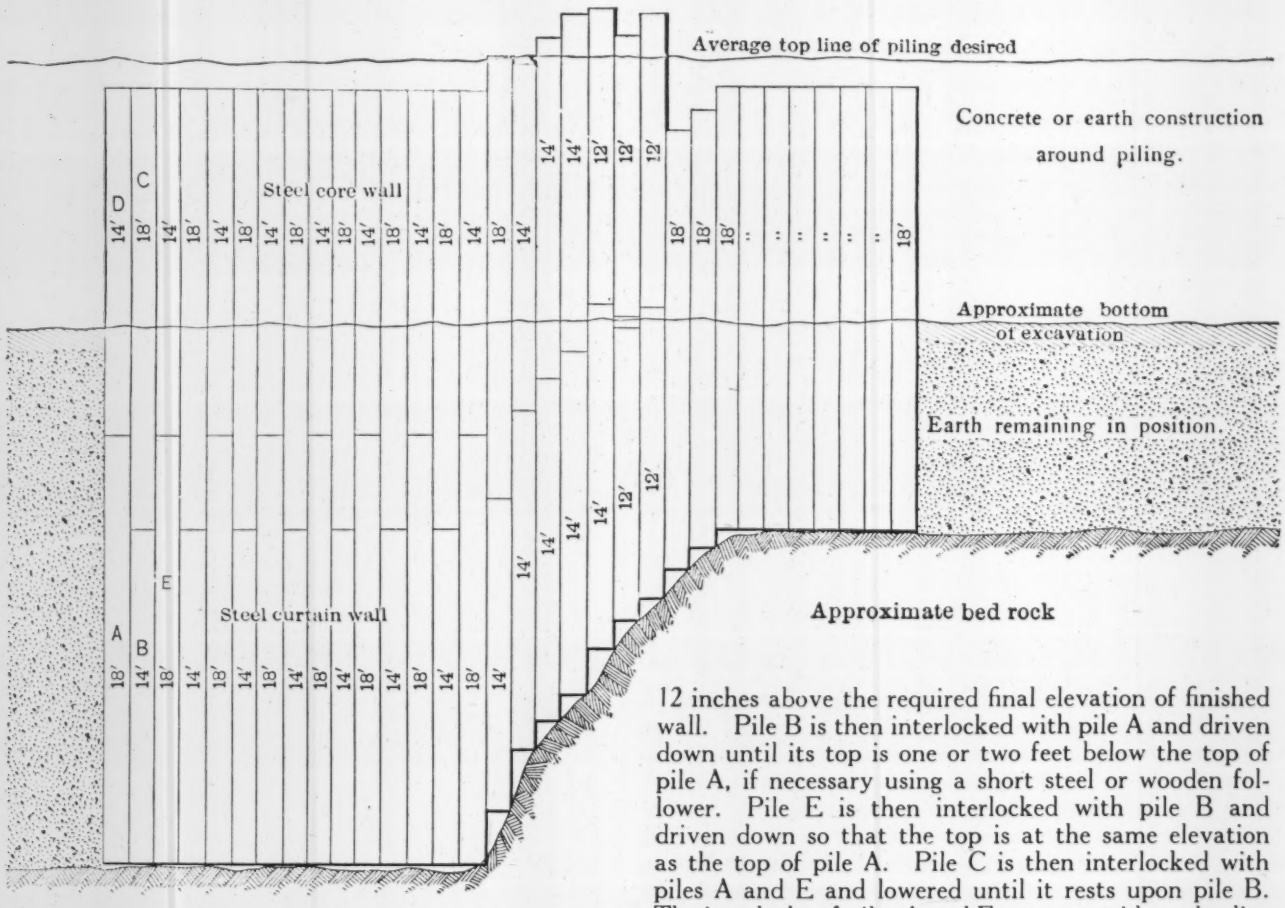

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Engineering News

CHARLES WHITING BAKER, *Editor*

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Engineering News

VOLUME 69 APRIL 24, 1913 NUMBER 17

The Recent Standpipe Failure at Cairo, Ill.

By G. C. Habermeyer*

The standpipe of the Cairo Water Co. fell at about 2:15 a.m., Feb. 11, 1913, as noted in Engineering News of Feb. 20, 1913. The standpipe was close to the pumping station and filter house, as shown in Figs. 1 and 2. It was built in 1885 by W. B. Maitland & Son, contractors, at that time of Peoria, Ill.

There were 37 courses of side plates ranging in height from 47 in. to 49½ in., built stovepipe fashion. In 1898, five courses of 5 ft. height each were added to the standpipe, making a total height of 175 ft. All vertical seams were double riveted and all horizontal seams single riveted.

The soil on which the standpipe was built consists of clays of varying composition for the first twenty feet from the surface and below this for a great depth it is a very fine sand. In constructing the standpipe foundation earth was excavated to a diameter of 24 ft.; piles about 35 ft. in length were driven on 2-ft. centers and cut off at the original ground surface and concrete was placed in the excavation between the piles to their tops. On top of the concrete six courses of Bedford stone about 15 in. thick were laid, the top course being 19 ft. in diameter.

The standpipe was anchored with eight 2-in. diameter anchor rods each having a loop eye at the bottom through which was placed a 2-in. bar. These bars were bedded near the top of the lowest course of stone and one bar found was 3 ft. 6 in. long. Dimensions of the standpipe are given in Fig. 3. It is stated that the standpipe was painted two coats at least once every two years, using mineral and oil on the outside and red lead and oil on the inside.

The standpipe fell to the northeast and in falling separated into several sections. One section wrecked the machine shop of the water company. One section fell

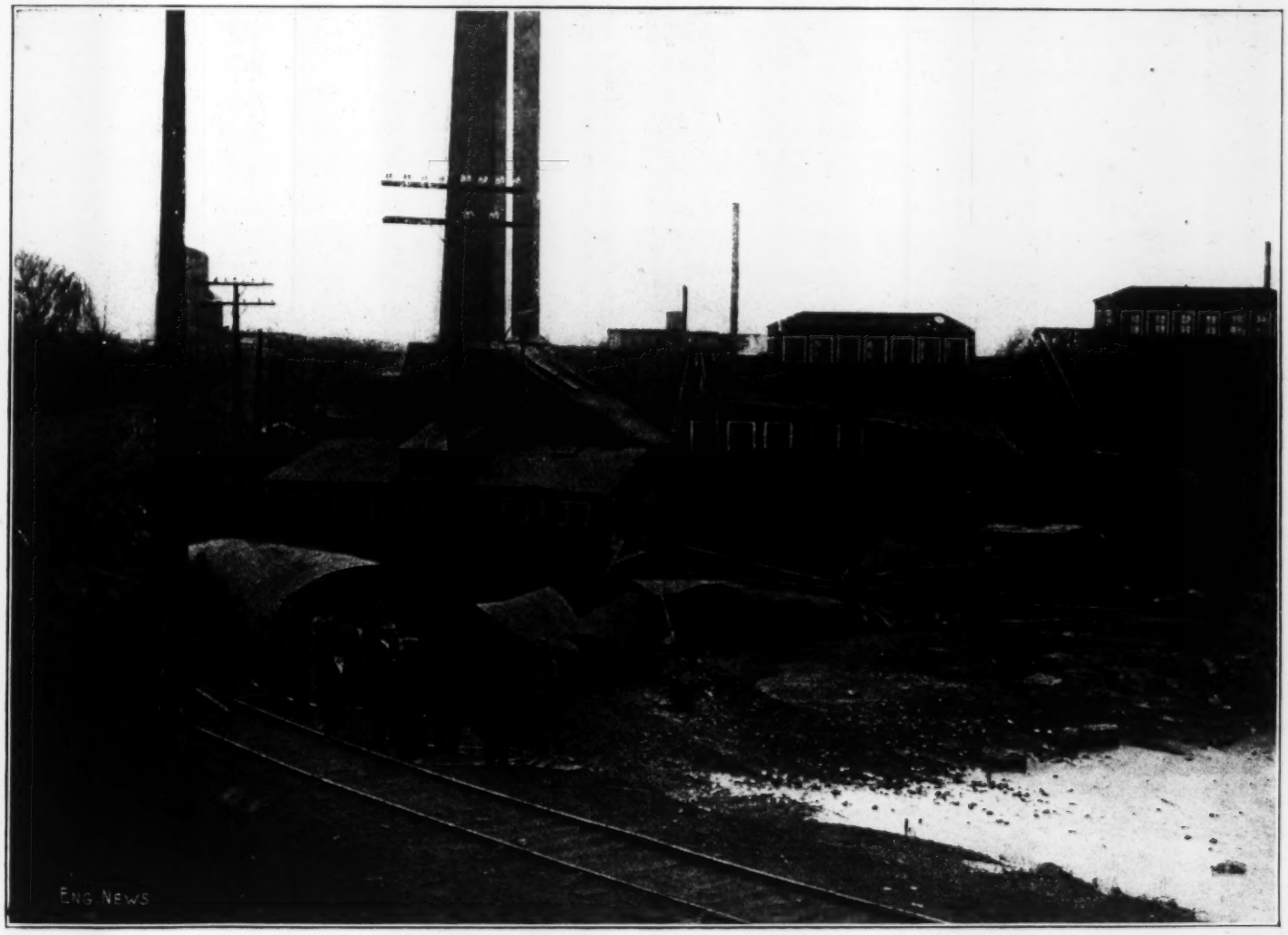


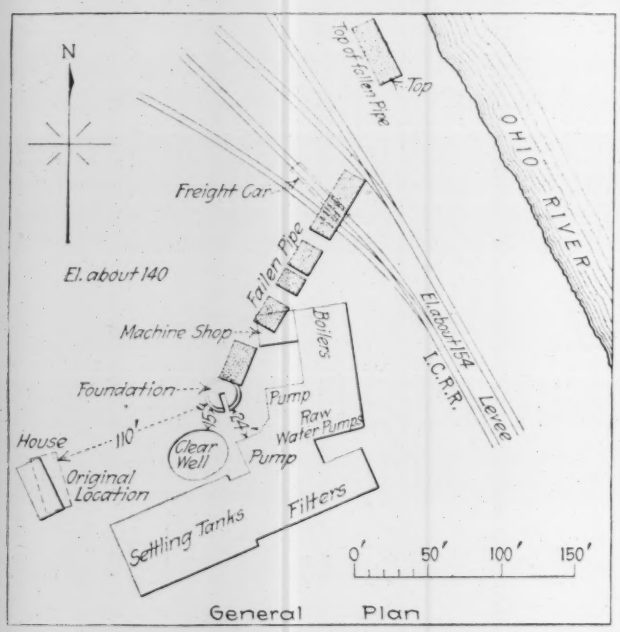
Fig. 1. General View of Wrecked Standpipe, Cairo, Ill.

*Associate in Municipal and Sanitary Engineering, University of Illinois, Champaign, Ill.

across the Illinois Central R.R. tracks, blocking traffic for several hours and wrecking a freight car. The top section fell along the bank of the Ohio River and wrecked a small house boat. The bottom plate was detached from the side plates and left lying on the foundation. The location of the fallen standpipe is shown in Figs. 1 and 2. The section falling on the tracks was moved west of the tracks before the photograph reproduced as Fig. 1 was taken. Water from the standpipe, which was full at the time of the accident, was deflected by the foundation and formed two main currents, one to the south and the other slightly south of west. Many of the stones of the foundation were washed a considerable distance away. The stream of water to the south and the stones carried by it wrecked part of the pumping station, as shown in Fig. 1. The stream to the west struck a house, 20x40 ft. in size, of light construction, moving it 7 to 12 ft., as shown in Fig. 2. The upper 3 ft. of the clear-water well was badly damaged. The greatest damage was the breaking of a water pipe that carried wash water to the filters. This compelled the water company to furnish unfiltered Ohio River water for more than two weeks. The condition of the foundation and plates just after the fall is shown by Figs. 1, 3, 4, 5, 6, 7 and 8.

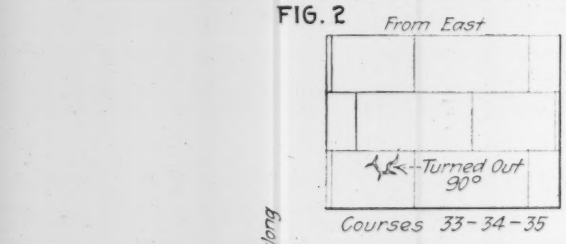
The standpipe was examined by the writer several days after scrapping had begun. The washing away of the stonework had left the tops of a few piles exposed at the location shown in Fig. 5. Those numbered 1 and 2 in the figure were fairly solid on top, but the tops of all other piles exposed were badly decayed. Measured to the highest point of each the distances down from a level with the top of pile No. 1 were: No. 2, ½ in.; No. 5, 3½ in.; No. 6, 5 in. The piles along the opening provided for the inlet pipe were 1½ in. or more lower than pile No. 1.

The upper part of the concrete of the foundation was very poor. A piece of wood molding was driven with a brick under the edge of the stone at an angle of about 30° with the vertical to the depth of 30 in. When withdrawn it was covered with black mud and grease. In the stonework there were some large spaces between the stones not entirely filled with mortar. The condition



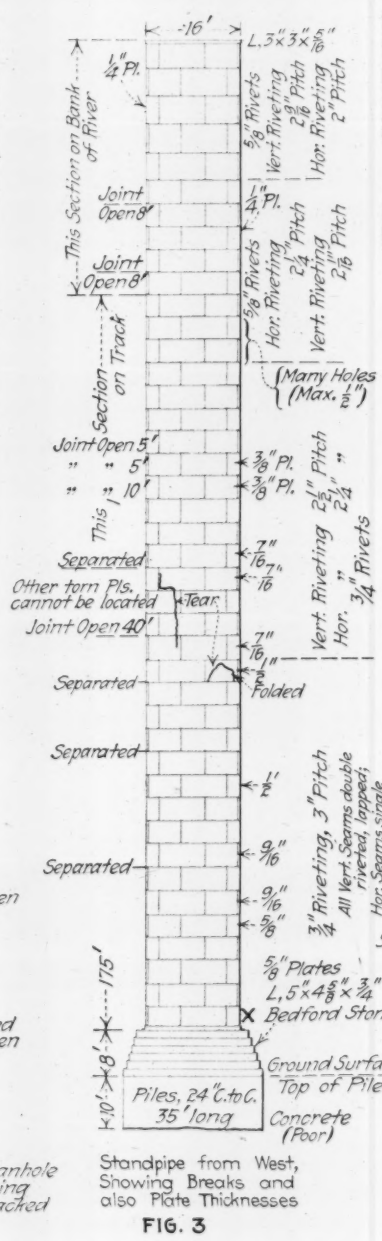
General Plan

FIG. 2



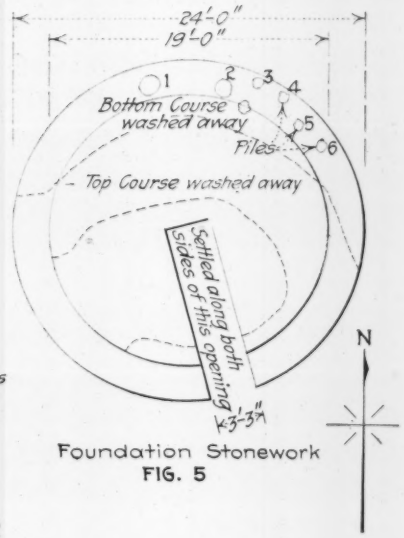
Details of Torn Side Plates

FIG. 4



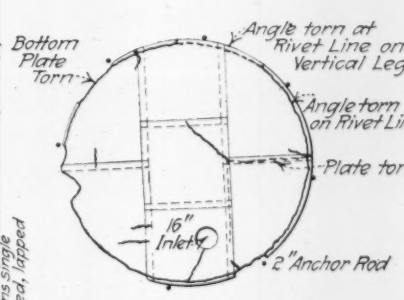
Standpipe from West, Showing Breaks and also Plate Thicknesses

FIG. 3



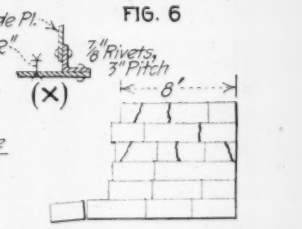
Foundation Stonework

FIG. 5



Bottom Plate of Standpipe, Seams Double Lap Riveted, 3" Centers

FIG. 6



West Side of Inlet Opening Showing Condition of best of remaining Stonework

FIG. 7

FIGS. 2 TO 7. DETAILS OF WRECKED STANDPIPE AT CAIRO, ILL.

FIG. 8. LOOKING TOWARD FOUNDATION ACROSS CLEAR WELL—SEE PLAN, FIG. 2.

FIG. 9. LOOKING TOWARD FOUNDATION AND PARTLY WRECKED PUMPING STATION

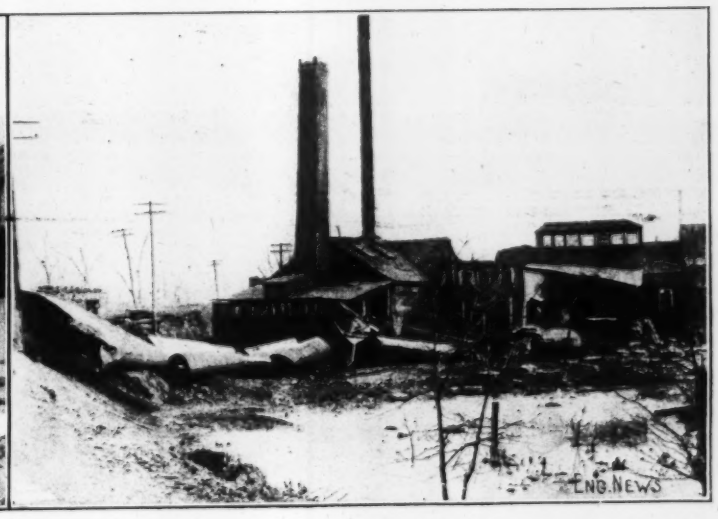


FIG. 10. GENERAL VIEW OF FALLEN STANDPIPE AND OF PUMPING STATION

FIGS. 8 TO 10. VIEWS OF WRECKED STANDPIPE AT CAIRO, ILL.

of the best of the stonework remaining in place after the fall of standpipe is indicated in Fig. 7. The west part of this remaining stonework was the highest, being 2 in. higher than the center.

The bottom plate of the standpipe was torn in several places, as shown in Fig. 6. The angle joining the bottom and side plates of the standpipe was of very poor steel and it was badly corroded in several places along the surface of contact with the bottom plate. The bottom edge of the lowest side plate was 2 in. above the bottom plate, bringing extra stresses on the angle joining the two. Views of pieces of the angle are given in Figs. 11 and 12.

Where sections separated in the fall it was by shearing of rivets excepting a few tears 1 or 2 ft. long and a tear about half way around the standpipe where the section that fell on the tracks separated from the section below. A number of the plates of the standpipe were torn

as shown in Figs. 1, 3, 4, 8, 9 and 10. Of the torn plates most of the damage must have been caused by the fall. The hole in Course 33, counting from the bottom, may have been caused by striking a corner of the house boat wrecked by the standpipe. In addition to the tears shown in Figs. 1 and 4 there were small tears in the lower courses of some sections evidently caused by striking the ground, a tear caused by striking the freight car, and some tears in plates not possible to locate in the sketch.

The inside of the lower plates was almost entirely covered with pits. The plates towards the top had small areas comparatively free from pits. In general, the maximum depth of pitting was $\frac{3}{16}$ in., even in areas which were comparatively free from pits. In Courses 30, 31, and 32, counting from the bottom, and to a limited extent in other places, the depth of pitting was ¼ in., entirely through the plate. The maximum diameter of the hole formed by the pitting was ½ in. Most of the holes were in the Course 31 from the bottom. In one space 3 ft.sq. there were nine open holes, and as many more had been plugged. No tests were made of the metal of the tank plates but they appeared to be of good steel or at least of fair quality.

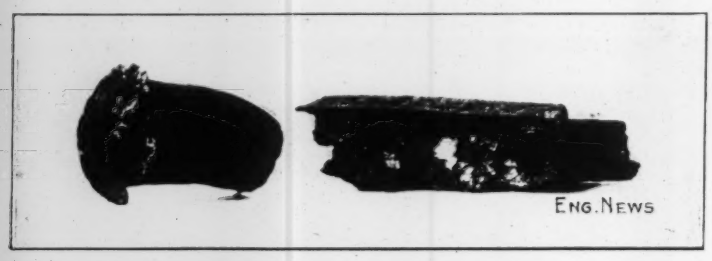


FIG. 11. RIVET AND PIECE OF ANGLE JOINING BOTTOM AND SIDE PLATES, CAIRO STANDPIPE, SHOWING CORROSION

That the thickness of metal had been reduced materially by corrosion was shown at a fracture 130 ft. from the base, where for a distance of 6 in. the average thickness was ⅛ in. Some rivet heads were eaten almost away, the damage being greatest in the courses where pits were deepest. A photograph of a rivet is shown by Fig. 11. In general, the plates were better at the lap than at other parts and where rivets failed in the fall it was by shear.

In determining the probable cause of the failure several possible causes may be considered. Few people had noticed any perceptible leaning of the standpipe. One person who passed it every day thought it had leaned in the direction opposite to that in which it fell. In painting the standpipe a few months before the fall, no lean was noticed. The city engineer, George Dewey, was quite positive the standpipe had leaned to the northeast for some time. No excavating had been done near the standpipe since twelve years ago, when the clear-water well was built. As stated, the west part of the foundation in place after the fall was 2 in. higher than the center, though this may not have been true before the fall. When water from the standpipe overflowed it ran over between north and east. All evidence considered, there can be no doubt that the standpipe leaned slightly to the northeast, but not enough to be noticeable to the average person or to be of itself dangerous to the safety of the standpipe.

At the time of failure the wind was blowing four miles per hour from the northwest and the maximum velocity for February had been 24 mi. per hr., so the wind could have had little part in the immediate cause of failure.

The temperature for February had been somewhat below freezing to Feb. 9, but the minimum for Feb. 10 was 35°, so ice could have had little to do with the failure.

There is a possibility that the first failure was in Course 33 from the bottom, where a plate was torn, and that the resulting reaction threw the standpipe to the west and increased the strain on the bottom plates on the west side, but it is more probable that this hole was caused by striking the house boat. The largest hole torn in the standpipe was on the west side, near the base, and it is probable the failure was at Point A as indicated in Fig. 4.

As stated before, the concrete of the foundation was very poor, and the tops of many of the piles had decayed. This resulted in a settlement around the opening left in the stone foundation for the inlet pipe and undoubtedly there was some settlement on the northeast side. This unequal settlement could cause considerable strain in anchor rods and side plates without allowing the standpipe to lean any great distance. The water which overflowed the standpipe and that leaking below this angle or through the bottom plate may have been a factor in the destruction of the foundation.

Rupture beginning on the west side would account for the location of the fallen parts, the bottom being carried a little to the east, but the fall of the upper sections being governed more by the leaning of the standpipe than was the lower section. The ladder which was attached on the west side of the standpipe was well under the fallen sections, indicating some rotation in falling. This might be caused by the holding of the anchor bolts on

FIG. 12. BREAK THROUGH BOTTOM PLATE AND ANGLE AT RIVET, CAIRO STANDPIPE
(Bottom plate below, angle above.)

east and southeast. A point which is interesting, though it aids little in determining the cause of failure, is the location of the top section of the standpipe. When the falling standpipe struck the freight car a glancing blow, as indicated in Fig. 2, it would tend to throw the standpipe to the north and if the bottom of the pipe were rotating to the south it would help this throw. As the upper part fell on ground probably 30 ft. below the top of the car there was time during the fall for considerable movement to the north.

To sum up: The bottom angle of the standpipe was of very poor steel and at the time of the failure, due to fracture and corrosion, probably had almost no strength. The large opening left for the inlet pipe was a source of weakness, especially when the stones along the edge of this opening settled. The foundation was in poor condition. The settling of the foundation gave the standpipe a slightly leaning position and the uneven surface caused by the unequal settlement produced higher stresses in some anchor rods and side plates than would be indicated by the amount of leaning. The west side of the foundation was probably highest and at this point the original rupture probably occurred. Some plates, especially those about 50 ft. from the top, were seriously weakened by corrosion. Some rivet heads were eaten almost away. It is concluded that unequal bearing, slight leaning and the weakness of the bottom angle caused a rupture at the base.

The standpipe had deteriorated seriously before the failure. A careful inspection would have revealed its critical condition. It would be of great advantage to water companies if standpipes and elevated tanks were inspected by competent persons at regular intervals.

[The impression in Cairo seems to have been that the standpipe had leaned for some time, as is shown by various local reports, including a statement to that effect in a letter which we have received from the city engineer, as given below. Assertions to the contrary are made by the water company (as noted in Mr. Habermeyer's article). Such an assertion will be found in the following excerpts of a letter on the failure sent to this journal by C. M. Ross, successor to T. W. Gannon, manager of the Cairo Water Co.

The impression that the standpipe has been leaning for a considerable length of time is without authority. From observations which we have made at our plant from time to time, the position of the pipe had not changed in the least for several years.

It appears to have simply broken from the very bottom, tearing away from the bottom steel plate, which remained intact on the foundation, and the entire pipe fell without collapsing until it struck the ground. It fell in such a position that it broke into several pieces when it struck, but not a single ring or joint showed evidence of having given way until after it had fallen.

The standpipe was full of water at the time of accident, which was our usual pressure. The condition of the steel is excellent, considering the length of time it had been used, which is due largely, of course, to the fact that it was always kept well painted and cleaned.

As stated in our previous letter, we account for the failure of the foundation, only through the long-continued high water, which must have weakened it.

A theory or explanation of the initial cause of the failure which is not mentioned by Mr. Habermeyer is given in a letter which we have received from George F. Dewey, city engineer of Cairo. This explanation, together with remarks on the alleged leaning of the structure, follows:

The site of the standpipe was only about 150 ft. from the bank of the Ohio River. This bank has been eroding for some time, as the channel of the river hugs the Illinois shore and the first pier of the Illinois Central bridge, which is only about five or six hundred feet north of the waterworks and about a hundred feet out in the stream, has caught a large amount of drift on the upstream side which throws the stiff current directly into the bank. This erosion to the bank keeps the stratum of sand open and during the high stages of river causes sand boils on the inside of the levees where the same sand stratum comes in close proximity to the surface. A large number of these sand boils developed last spring in the south edge of the ridge on which the waterworks are located, these boils being about from 1200 to 2000 ft. west of the works and near the center of town. I am of the opinion that the water from them came from the river bank in the neighborhood of the water-works, and that from that cause the weakening of the standpipe foundation occurred.

The lean had been noticeable for some time and, I believe, had become more pronounced during the last high water. The lean was in a northerly direction, and it is remarkable that it did not do any more damage than it did. The bottom plate did not leave the masonry foundation, but was detached from the wall plates as if cut off and the bottom plates forming the wall were torn in two, in various ways.

The water was nearly all discharged near the bottom with great force, demolishing the masonry base and throwing the large stones as much as 150 ft. distant. Some of the large foundation stones were thrown in such a way as to demolish the walls of the pump house. The new Allis-Chalmers pumping engine, installed this last summer at a cost of $40,000, was covered with débris, and one of the large discharge pipes was broken. As soon as the débris was cleared away and a new pipe put in the old pump was put to work and the water service resumed. Had the standpipe fallen in any other direction, especially east or south, the loss would have been much greater and the city water-supply cut off indefinitely.

How much the failure was due to foundations weakened by saturation of the ground and how much it was due to the deterioration of the metal it is, of course, impossible to state.—Ed.]

⁂

The Good-Roads Year Book, just issued by the American Highway Association, states that there are now over $400,000,000 bonds outstanding, which have been issued by states and counties to pay for good road construction. Of the entire mileage of public highways in the United States, it is now estimated that 10.1% have been improved to a greater or less extent.

⁂

The Potash Deposits of Death Valley, California, are reported on in a preliminary bulletin of the U. S. Geological Survey, which has recently studied the general locality for the possibility of deposits here. A vast amount of saline material has accumulated on and beneath the floor of the low-lying desert on the southeastern borders of California, known as Death Valley and it was logical that this area should have been one of the first to attract attention in the country-wide search for soluble potash salts (much needed in the manufacture of commercial fertilizer, which has to rely on the product of German mines). The locality examined comprises a central area of crusted salts extending for many miles from north to south in the lowest part of the basin. At the very lowest part is a circular area, several miles across, which is usually a smooth field of snowy white salt. Occasionally this is flooded by storm waters, which subsequently evaporate and leave the surface white again. Beyond this smooth area, to the north and south, are fields of rough salt, differing principally in that the salt crust has been gradually broken into cakes and tilted up at various angles and has not been inundated.

Three test wells were placed in the area of smooth salt in the lowest depression of the valley and a fourth in the area of rough salt twenty miles north of the others. The records of all are very much alike and show that the valley is underlain by an alternation of layers of silt or clay with layers of rock salt. Salt brines were encountered at several horizons, but no one of these was under such pressure as to cause it to rise and flow out the well.

The potash content was not unusual in any way, being close to the average generally found in natural basins of desert regions. No shore markings or evidence of deep submergence of this valley have been discovered, and the deposits are supposed to have been built up layer by layer, a process that is still going on. A vast amount of saline material is accumulated at the bottom of the valley, but the mode of deposition is not favorable to selective crystallization on a large scale. Segregation of potash perhaps has occurred in the several layers, but on a scale so small as to be of doubtful importance. Unless a vast body of material has been deposited at one time during a single period of dessication, there is little chance for the various dissolved constituents becoming segregated on a large scale. There is no record of the drying up of a single large lake in this valley. Such a condition, however, is found further west, at Searles Lake, and others may occur in the Western desert regions, although not now exposed at the surface.

Replacing a High Timber Trestle with a Steel Viaduct

The Fort Dodge, Des Moines & Southern Ry. is an electric road (with about 170 miles of line) formerly operated by steam. In 1906 it adopted on a part of its line, the trolley system with 600-volt direct-current for operating its passenger service (the freight service being still handled by steam locomotives), and in 1912 it adopted 1200-volt direct-current for both passenger and freight service. Its main line is between Des Moines and Fort Dodge, Ia., a distance of 86 miles. About 2½ miles north of Boone, Ia., the line follows the east bank of the Des Moines River, running along the high bluffs at a considerable height. These bluffs rise about 300 ft. above the river and are cut by a series of deep ravines so that the line alternately cuts through a bluff and spans a ravine. There are five ravines in the course of a mile, and these are crossed by timber trestles which range from 40 to 156 ft. in height and from 200 to 800 ft. in length. These were built in 1903. During recent years it has been considered wise to eliminate these trestles, both for the safety of operation and as a permanent improvement to the line. The smaller ones were filled in with solid embankments and the largest has been replaced with a steel viaduct. This trestle was 800 ft. long and 156 ft. high at the deepest point. It was supported on oak piles and built of frame bents with 12x12-in. posts and 12x12-in. caps, and was well braced with 6x8-in. struts and sways. The bents were spaced 16 ft. apart. The trestle contained a total of 860,330 ft. b. m. of timber, 5968 lin.ft. of piling and 22.4 tons of iron. This trestle is shown in Fig. 1. The new steel structure is a plate-girder viaduct, 784 ft. long and 156 ft. high, with spans of 32 and 80 ft. It was designed by W. M. Hughes, of Chicago, as Consulting Engineer for the railway, and was built and erected by the American Bridge Co. To that company and Mr. Hughes we are indebted for information and plans. The description of the construction work has been furnished us by C. J. Steigleder, Assistant Engineer of the Ft. D., D. M. & S. Ry.

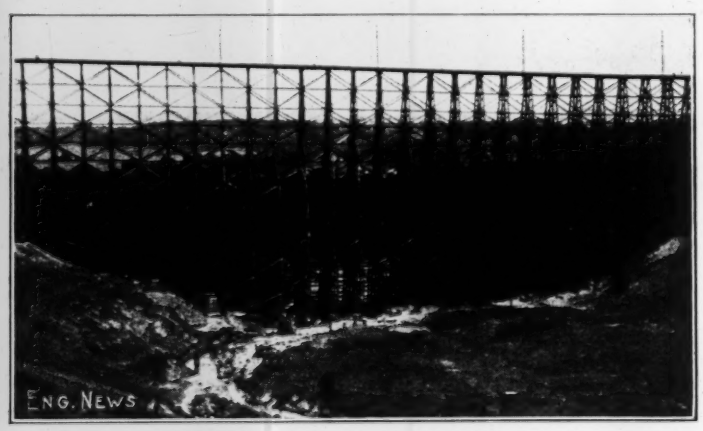


FIG. 1. TIMBER TRESTLE 800 FT. LONG AND 156 FT. HIGH

(Now replaced by a steel viaduct. Fort Dodge, Des Moines & Southern Ry. (electric).)

GENERAL DESIGN OF STEEL VIADUCT.

With a regular train service at two-hour intervals it was necessary to plan the reconstruction work so as to avoid interference with traffic. Several preliminary surveys were made to determine the amount of grading necessary on different locations, and it was decided to locate the new structure alongside of the old one (and upon the inner or up-hill side of the latter), with its center line 14 ft. from that of the old structure. This left the deck and track of the trestle undisturbed and open for traffic, although the steel towers encroach upon the lower part of the trestle. This arrangement effected an improvement in alignment, as at the north end it enabled a reverse curve of 2½° to be rectified although at the south end it gave a curve of 5° 15′ instead of 5°. A preliminary design for the viaduct, which apparently overlooked the conditions of erection, included 36-ft. spans. But this would have involved great difficulty in placing the foundations and towers, as some of the steel bents would have been close to or coincident with the positions of the trestle bents. In Mr. Hughes' design the spans are all multiples of 16 ft. (the spacing of the trestle bents) so that the foundations all come in open spaces and the tower legs interfered only with the bracing of the trestle. The tower spans are 32 ft. and the intermediate spans 80 ft., with a 48-ft. span at one end.

The design of the viaduct is shown in Fig. 2, and on this is shown the arrangement of the concreting plant, which is described below. Fig. 3 shows the typical tower design. To the girders are attached bracket frames for the trolley poles, there being a bracket at one end of each 80-ft. girder and the 48-ft. girder. The batter for the sides of the towers is 1 : 6. The girders are spaced 7 ft. c. to c., and the 48-in. girders of the tower spans have end pedestals to bring their tops level with those of the 90-in. girders of the longer intermediate spans. The structure is designed for the live load of Cooper's E-45 classification (two 156-ton engines followed by a train load of 1500 lb. per lin.ft. of track). While this is heavier than would be required for the present equipment, using 40-ton and 70-ton electric locomotives in the freight service, it was considered that the size and weight of such engines is likely to increase, as has been the case with steam locomotives. The dead load is taken as 1400 lb. per lin. ft. of track for the 80-ft. spans, 1000 lb. for the 32-ft. spans and 1200 lb. for the 48-ft. end span. The specifications followed were those of the American Railway Engineering Association, except that the columns are not figured for traction stresses and that the impact allowance is only 50% of that given in those specifications. An interesting feature of the steel structure is the extensive duplication of parts, in the towers as well as in the spans. There are six 80-ft. spans, seven 32-ft. tower spans, and two end spans of 48 ft. (at the south end) and 32 ft. (north end). The 80-ft. girders were riveted up complete in the shops, and the 48-ft. and 32-ft. girders were riveted complete and assembled in pairs with bracing, for shipment as completed spans. The upper sections of the bents (Nos. 5 to 10 inclusive) were all made alike, the difference in height of bent being made in the bottom section. Each column is composed of two 15-in. channels with an 18-in. cover plate over the flanges of the outer face, and a 4-in. reinforcing bar on each of the flanges of the inner face.

The nature of the ground at the side of the bridge is complex, being composed of several formations which range from soft yellow and blue clay to rock. At the bottom of the ravine and in the bed of the stream, it consists of large loose boulders and gravel. Beneath this

is a blue joint-clay such as is commonly found over coal measures. The yellow clay, being the upper formation, is very hard when dry, but when water is present, it becomes very slippery and evidences of slip can be seen

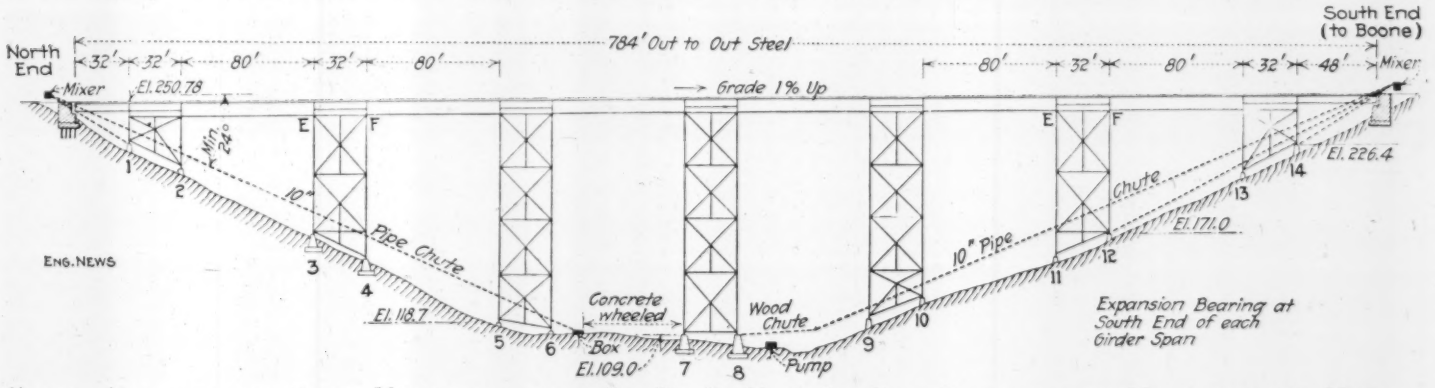


FIG. 2. ELEVATION OF STEEL VIADUCT FOR THE FT. D., D. M. & SO. RY.; SHOWING THE MAXIMUM AND MINIMUM INCLINATION OF PIPE CHUTES FOR DELIVERING CONCRETE TO THE PIER FORMS

in several places on the hillside. It was thought at first that it would be necessary to drive piling for the footings of the abutments and pedestals, with the exception of those pedestals at the bottom of the ravine. Upon excavating at the site, it was found that by going deeper with the foundation, a good bearing could be obtained

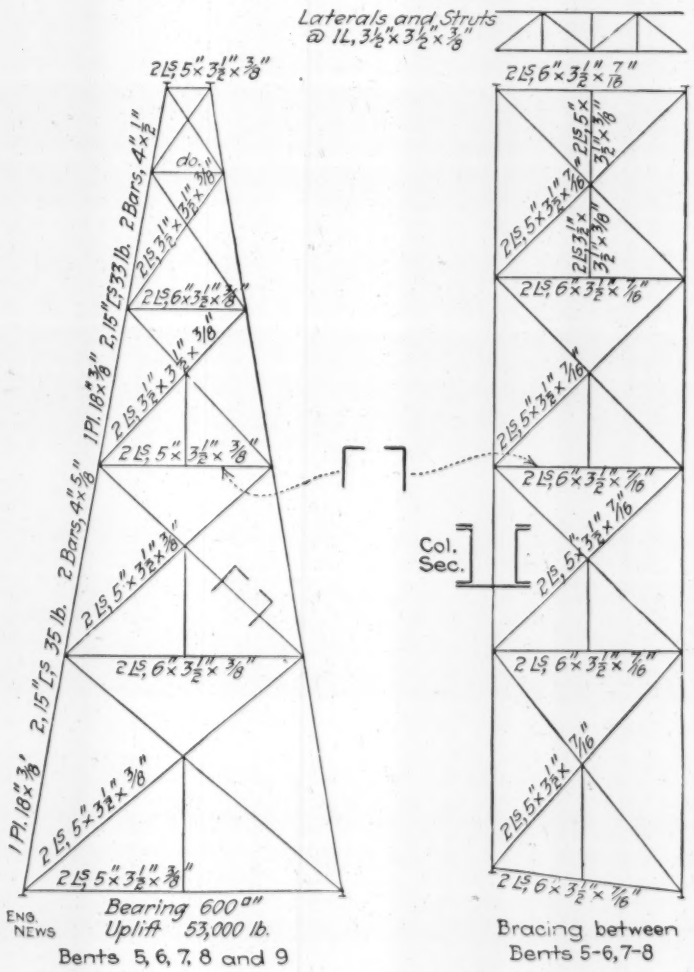


FIG. 3. TOWER BENTS FOR STEEL VIADUCT; FORT D., D. M. & SO. RY.

without piles. This was done and the excess concrete used over the original plans only amounted to 211 cu. yd. The piers (with one or two exceptions) were designed with a footing 10 ft. square and 3 ft. deep, and a pedestal 7 ft. high, 4x4 ft. on top, having a batter of 2 in. per ft. on the sides. For the majority of the piers, this gave a bearing area of 100 sq. ft. The safe bearing on hard clay is from 4 to 6 tons per sq. ft., thus giving an allowable pressure of from 400 to 600 tons. The largest pier placed was No. 9 (east), having a footing 12x12 ft., 7 ft. deep and a pedestal 11 ft. high, the total weight being approximately 90 tons.

FORMS AND CONCRETE WORK.

The forms for the pedestals were made of 2x8-in. lumber, dressed on one side. They were built in four sections, each section forming one side of the pedestal. Two sections were cut to the exact dimensions of the pier, while the others were made to overlap the inside section, giving room for a 2x4 in. stop. The upright studding was of 2x4 in. sticks, one placed in the middle of the form section and one at each edge. Where forms higher than 7 ft. were used, they were wired across the inside to keep from bulging. Strap bolts were fastened to the inside corner and the cracks were battened with lath on were bored in the outside section to receive the threaded ends of the bolts, and hand nuts were used to keep the sides in place. A ¼-round molding was placed in each inside corner and the cracks were battered with lath on the outside. Six forms were used on the work, four 7 ft. high and two 9 ft. high. Where forms of other heights were needed, they were made by splicing on or cutting off from those already made. Fig. 4 shows the detail of the forms, including the strap bolts and hand nuts.

The specifications called for 1 : 3 : 6 concrete, except for the coping course, which was considered the top of the pedestal (12 in. thick) and was made 1 : 2 : 4. The stone used with the 1 : 3 : 6 mixture was from 1 to 2 in. in largest dimensions, and for the 1 : 2 : 4 mixture not more than 1 in. in largest dimensions. All stone was screened, no crusher run being used. It was a good grade of limestone rock. The sand was taken from the Des Moines River about five miles up from the site of the bridge, using a standard brand of cement. The water was secured from a creek in the ravine, a 7-hp. gas-engine pump being used to force the water up the hill through a 1½-in. pipe into storage barrels at the mixer. The concrete was made with a batch mixer, driven by a 6-hp. engine mounted on the same frame.

DISTRIBUTING THE CONCRETE.

An interesting feature of this work was the manner of placing the concrete. Owing to the steep slope of the hill, it was impracticable either to move the mixer down the slope, or to wheel the concrete into place. The most efficient way was to spout it and this was the method

used. Half of the piers were poured from the north end of the bridge, and the other half from the south end. The mixer was mounted on blocks and a platform, built around it so that the hopper was above the platform, just about the height of a wheelbarrow. The chute used to convey the concrete was of No. 23 sheet steel, circular in form, 10 in. diameter, and in lengths of 10

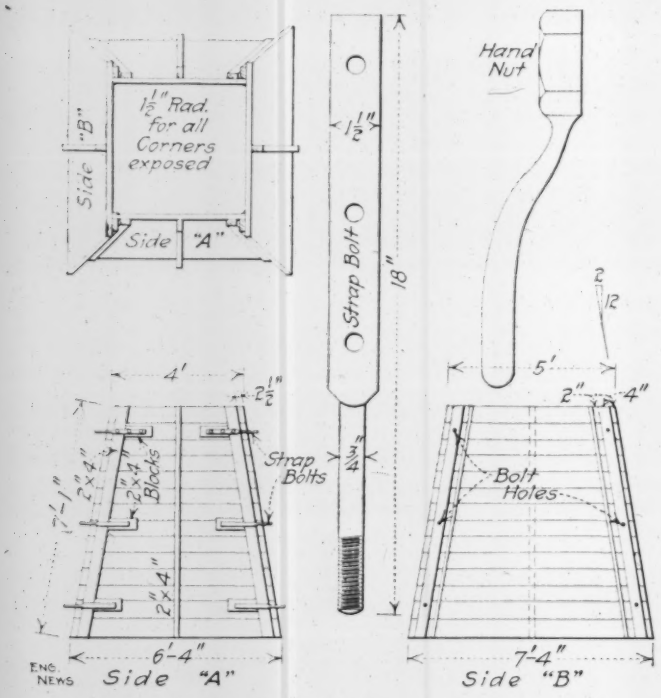


FIG. 4. FORM CONSTRUCTION FOR CONCRETE PEDESTALS OF VIADUCT

and 12 ft. The pipe was attached to a small wooden chute at the end of the hopper, and from here run to any desired point. It was supported at joints by wooden cross frames, or by brackets tacked to the batter posts of the trestle. At the end of the pipe, a curved connection was used to turn the concrete down into the forms. The spouting is indicated on Fig. 2, and the concrete

FIG. 5. CONCRETE-MIXING PLANT, WITH STEEL PIPE CHUTE TO FORMS FOR PEDESTALS

mixer and spout are shown in Fig. 5. For bent No. 8, the concrete was delivered through a wooden chute from the end of the pipe chute just beyond bent No. 9. For bent No. 7, the concrete was wheeled into place from a wooden box placed at the end of the pipe chute just beyond bent No. 6 (See Fig. 2). This type of pipe spouting proved satisfactory where the distance was not greater than 250 ft. and the grade not less than 24° with the horizontal (about 1 ft. vertical to 2.3 ft. horizontal). When on a less grade than this, the concrete clogged in the pipe and caused considerable trouble. If it clogged so that any amount of weight would come between supports, the pipe would buckle and break, making it worthless for use again. Mr. Steigleder considers that a better type would be a chute made of similar material, 10 or 12 in. wide, 16 or 18 in. deep, open at the top and with a small angle running along each edge. Occasional spacer angles could be used to stiffen it. This pipe or chute would be easy to handle and it would give access to the concrete flowing in it. Another good type of spouting for this kind of work would be a wooden chute in 12- or 16-ft. sections, lined with sheet iron. The advantage of this chute would be the saving on the investment, as after the job was completed the lumber could be used for some other purpose.

The concrete gang was composed of 12 men and a foreman. Two men were used in spading the concrete as it was placed, one on water and dumping cement, one taking care of the mixer, six on sand and rock, and two carpenters. As far as possible, the concreting on a foot-

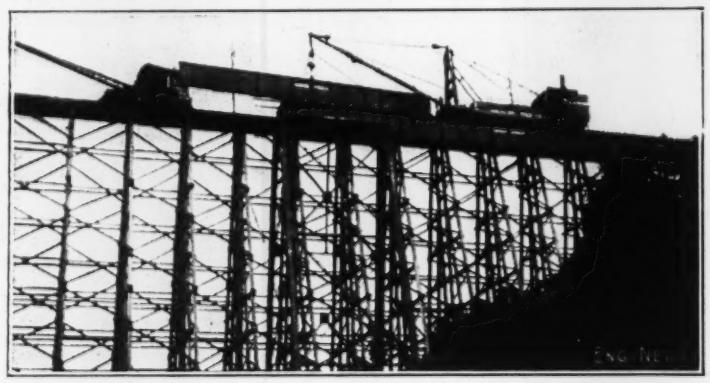


FIG. 6. PLACING AN 80-FT. GIRDER ON THE BOONE VIADUCT FOR THE FT. DODGE, DES MOINES & SOUTHERN RY.

(The erection was done by a derrick car on the viaduct and a locomotive crane on the old trestle alongside the viaduct.)

ing or pedestal was continuous, and only in one or two cases were joints made in either. From four to six footings were run at a time. As soon as the first two of these footings had set, the forms for the pedestal were placed and securely braced. After being braced, the template for the anchor bolts was centered and tacked to the top of the pier form. The anchor bolts were then placed in the template, plumbed and wired to the form. The total amount of concrete in the foundations was 932 cu. yd. The time required to place this was 40 days.

ERECTION OF STEEL STRUCTURE.

The cut at the north end of the bridge was excavated with a steam shovel, and about 300 ft. of track was laid on the new alignment. This track was used for unloading the steel and for the derrick car during erection, also as a siding when necessary to clear the main line for traffic. The erection was started at the north end and carried through to the south. The first 32-ft. span and the first bent of tower No. 1 were erected by the derrick car, which had a 40-ft. boom. The rest of the towers were erected with a locomotive crane which worked from the old trestle. The tower was first erected

and then the girders were placed, the ties and rails being laid as the work progressed. The material for the towers was first lowered through the side of the trestle by the derrick car (the bracing being removed as necessary), and was then picked up by the crane and brought into place. After a tower was completed, the derrick car placed the 80-ft. girders. These girders weighed approximately 16 tons each but no special apparatus was needed to place them, as the boom on the derrick car was kept straight ahead. Fig. 6 shows the derrick car placing an 80-ft. girder on the third span.

No difficulty was experienced in keeping the line open for traffic. The track was cleared ten minutes in advance of all regular trains, and in case of extra trains the foreman on the work was notified of their approach by the dispatcher. In order to protect the locomotive crane from the 1200-volt current on the trolley wire, a breaker was put on the wire and the current was cut off while the crane was working. The only trouble that was encountered during the erection of the steel was that caused by the bracing of the trestle interfering with the columns or braces of the steel towers. At the expense of the railway company, a carpenter gang of six men and a foreman was kept busy cutting away the old woodwork as required. The sway braces and struts that were cut were not replaced. When it was necessary to move a post, the cap was jacked up and the post cut and then moved and blocked into place. The trestle is to be wrecked but the contract for this work has not been let. The best of this timber will be milled and then disposed of, while some of it will be used in repairs to other bridges.

The deck of the viaduct has yellow-pine ties 8x8 in., 10 ft. long, sized to 7½ in. Hook bolts are placed on every other tie and the rails spiked to all ties. The guard rail is 6x8 in., boxed 1 in. over each tie. Three steel guard rails are laid between the track rails. The third guard rail is placed in the center of the track and provides an extra precaution in case a motor casing should drop as a car is crossing the bridge.

The riveting was done with compressed air, the power for the compressor being supplied part of the time by the engine on the derrick car and the rest of the time by a gas engine. From 12 to 18 men were used during erection, and from 10 to 12 during riveting. The bridge was erected complete before the riveting was started. From three to four gangs were used to drive the rivets, the greatest number driven in one day being 1020, with three gangs working. The time required to unload the steel and erect the bridge complete (including the placing of the ties and rails) was 95 days. The contract for the foundation was let to A. W. Merrick, at Boone, Ia. The excavation was done by the railway company. The painting was included in the contract for the erection.

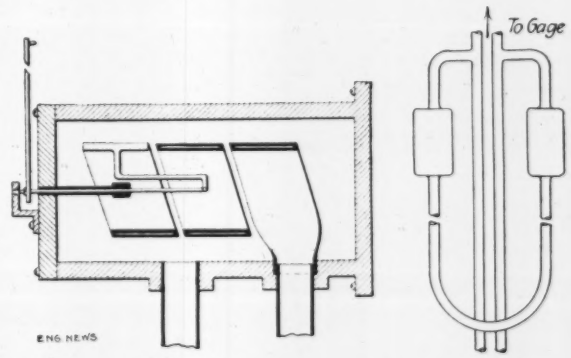
❀

Painting of the Panama Lock Gates is noted in the "Canal Record," Mar. 6, 1913. At present the work is confined to the interior surfaces of leaves. There is a preliminary washing of the steel to make the paint adhere better. Then there is the application of a "bitumastic enamel" to an average thickness of $\frac{1}{16}$ in. This type of paint has been used on the interior of the sea-going section dredges "Culebra" and "Caribbean" and has worn well during six years of service. This interior painting is being done by the lock-gate contractor under a sub-contract. The exterior paint has not been fixed and will be purchased by the commission but applied by the contractor.

A New Recording Differential Pressure Gage*

Design of a line of recording differential pressure gages has recently been completed by Prof. W. H. Bristol, of Waterbury, Conn., to meet the demand for service with Venturi meters, pitot tubes, orifices, etc., in the measurement of flows of steam, gas and air, as well as water and other liquids.

The mechanism employed is a development of earlier arrangements of hollow springs or diaphragm chambers bearing pressure on the interior and showing pressure changes by changes in shape, which movements are communicated to a pointer or pen arm. With a differential gage, it is desired to measure the difference in pressure between a greater and a lesser pressure. The one is applied to the interior and the other to the exterior of the hollow spring or diaphragm chamber; the corresponding movement of spring or diaphragm is proportional to the difference between the two pressures. Various attempts have previously been made to accomplish this end by inclosing the hollow spring or chamber in a casing and communicating its movement mechanically to the exterior through the casing walls, but the differences in pressures have been small to render negligible the friction of stuffing boxes or equivalent devices. Prof. Bristol has used this type of movement, but has devised for the casing



Diagrammatic Arrangement of Working System and Safety Attachment; Bristol Recording Differential Gage

a practically frictionless sealed bearing for the pointer or pen-arm shaft. As shown in the accompanying figure, a small shaft bearing the arm passes through a long fixed tube or sleeve and, fitting closely therein, oil or other liquid may be used to fill the annular interstice. This supports the shaft and renders the joint very nearly frictionless to rotation while capillary forces make it also pressure tight.

Where there is danger of applying the full pressure to one side or other of the hollow spring or chamber, which might result in wrecking the gage, a safety appliance is attached. As shown in the accompanying figure, the two pressure leads carry outlets which are joined by a U-tube. Near the top of the U-tube are chambers, either of which has sufficient capacity to hold all the liquid contained in the U. When pressure is communicated to one lead and not to the other, the U-tube is cleared of liquid and full pressure is communicated to both sides of the spring or diaphragm chamber.

*From information furnished by the Bristol Co., Waterbury, Conn.

Stream Gaging Stations as Component Parts of Water-Power and Other Hydraulic Works

By John C. Hoyt*

Until recently stream-flow data have been used principally in determining the feasibility, the capacity and the design of various types of hydraulic plants whose successful operation must depend on the flow of streams. There is now a large and growing demand for these data for use in connection with the operation of such plants.

In the production of hydro-electric power full data in regard to the quantity and distribution of the water-supply are at all times essential. These data not only form the basis for the operation of the wheels and for estimating their working efficiency, but are also necessary for the equitable distribution of a supply of water that must be utilized by several plants. On irrigation projects records of stream flow, both for the source of supply and for the various distributing canals, are fundamental to the equitable distribution of the water and the determination of the seepage and other losses which affect the successful and economic operation of the system. For municipal water-supplies, navigation, storage, and other hydraulic works, records of flow are becoming more important, and with the present intensive development of surface waters these data will be essential to the operation of all types of hydraulic plants.

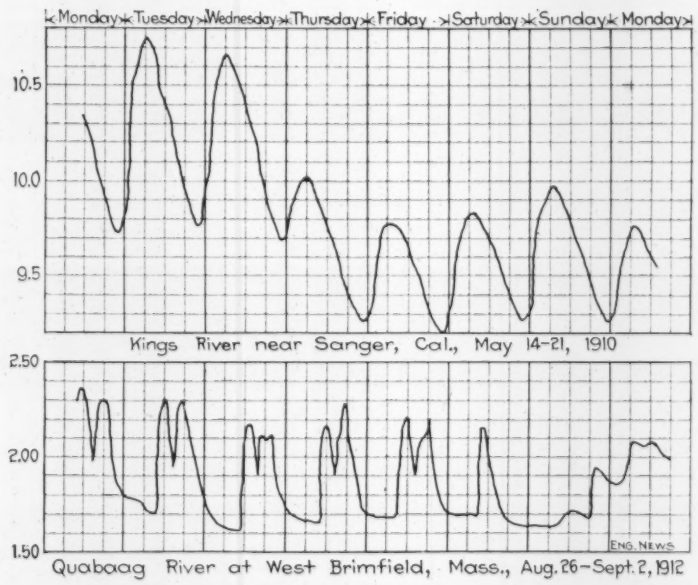
The need for stream-flow data in connection with hydraulic operations has been met in various ways. At power plants data have been obtained from records computed from wheel ratings, and from flow over dams and through waste channels, and some estimates have been based on electrical output; at irrigation projects headgates and other existing structures have been rated; and for other uses various expedients have been adopted, the choice depending on the character of the plant. Data obtained by any of these methods will always be more or less unsatisfactory on account of the many uncertain and changing conditions which affect their accuracy, and they can never replace records derived from observations at properly selected current-meter gaging stations, which at all times afford data sufficiently accurate to determine any of the various factors involved in hydraulic operations.

In designing hydraulic plants stream-flow data are used to determine the quantity and distribution of the water which will be available when the plant is in operation. In such designs a liberal factor of safety must be allowed to provide for the wide variations which occur both in the total flow and in its daily distribution from year to year. The total annual flow of a stream may be 50 to 75% greater or smaller than the mean annual flow for a series of years and extreme floods and droughts may vary as much as 100% from the average high and low waters. Therefore, so great refinement in data is not essential when the records are to be used for design as when they are to be used for operation.

In operating a plant it may be necessary to know precisely the conditions of flow that exist at any time during the day. Gaging stations to obtain data for operation must, therefore, be equipped and maintained to provide records of a high degree of accuracy.

The gage heights must be recorded by an automatic gage so that the record may be available at any time and errors due to diurnal fluctuation in stage eliminated. Not uncommonly the difference between estimates of discharge determined from hourly readings on a recording gage will vary 75% from those obtained by one or two gage readings a day, as shown on the typical gage height curves reproduced herewith. The discharge measurements must be made with exceptional care in order that no appreciable errors may be introduced into the rating table.

Special care must also be taken in selecting the point for making the measurement and, as a rule, it will be found necessary to install a cable and car from which the measurements can be made. The cost of such a station with the most modern equipment will range from $1000 to $1500, the exact amount depending on local conditions, and is small compared with the total cost of most hydraulic plants and the importance of these records in its operation.



Fluctuations in Stream Flow within Daily Periods

That the average engineer does not appreciate the importance of stream-flow data in connection with the operation of hydraulic works is evident from the fact that only exceptionally is suitable provision for stream measurement made in the design and original construction. Among the requests received by the Water Resources Branch of the Geological Survey for coöperation in the collection of stream-flow data for operative purposes, requests for data for determining the efficiency of wheels at power plants are common, and in practically every case a gaging station must be established, to determine the quantity of water available with any reasonable degree of accuracy. If such a station had been considered in designing the plant much more satisfactory results could have been obtained at a much less expense, as in the construction of most plants, a gaging section can be provided for with but little extra work.

The same lack of provision for collecting stream-flow data is found in connection with the operation of various irrigation projects. The designing engineers have evidently overlooked the fact that the success of a plant de-

*Engineer-in-charge, Division of Surface Waters, U. S. Geological Survey.

pends largely on the readiness with which the works may be operated and the burden of this oversight must be borne by the operating engineer. With the increased development of the water resources of the country the value of water has risen rapidly, so that supplies which were formerly considered abundant now have to be conserved and used with discretion. Legal difficulties frequently occur and the adjudication of water rights is one of the difficult problems which many communities must now solve. In order to be prepared for any contingency the owners of all plants and projects which depend on the flow of water in streams for their successful operation should keep both for their present and future needs accurate water-supply records, while provision for the collection of stream-flow data should be considered both by the designing and the constructing engineer.

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Algae in the Water-Works Reservoir at Quincy, Ill.*

By W. R. GELSTON†

There was published in "Engineering News," June 9, 1898, an interesting article by Dow R. Gwinn ["Covering a Storage Reservoir at Quincy, Ill."]. I quote from Mr. Gwinn's article:

The reservoir was constructed in 1881-2, and is 415x317 ft. at the top and 26 ft. deep. The excavation made the embankments. The inside slope was puddled to a depth of 9 in. and a dry limestone wall 1 ft. deep was laid on the puddle. The bottom, which is sandy clay, was puddled to a depth of 1 ft.; the leakage, if any, is extremely small.

A vegetable growth has given us considerable trouble during the summers, especially since we began filtering the water before pumping it into the reservoir. The character of the vegetation was not always the same; one year it was a mossy growth, but the last two summers the growth was about the size of the head of a pin, nearly globular and light green in color.

A wooden roof was built over the reservoir, presumably in 1897 or 1898. This was removed in 1906, because the wood was becoming badly decayed and dropping into the water, giving it a disagreeable taste.

In July, 1907, the gate valve controlling the flow of water into the reservoir was closed and the water was treated with copper sulphate in the proportion of 1 to 365,000 parts of water. It was allowed to stand 30 hours and was then drained through a pipe provided for that purpose. An attempt was made to clean the interior, but it was not very satisfactory on account of the mud in the bottom. No trouble, due to algae, occurred during this season.

Beginning in the spring of 1908, we adopted the policy of treating the reservoir with copper sulphate (1 to 5,000,000 parts) and repeating the treatment every four weeks during the warm season. There were eight or nine treatments each year, the first being given in March or April and the last in October or November. These treatments were always given as early in the day as possible, after the pumps were started, and without shutting off the reservoir from the distribution system. The pumping plant was then kept in operation about 36 hours, so as to hold the treated water in the reservoir until there was no danger of the consumers noticing an unusual taste.

This method of treatment has been very satisfactory and until the latter part of the summer of 1912 there was no evidence of any objectionable growths of any kind. The first indication of such growths came in August and September when there were a few small patches of floating vegetable matter (none larger than 3 or 4 sq.in.), and the rip-rapped slopes were covered just under the water with a thin layer of green moss from which bubbles were rising to the surface. At this time the water had no disagreeable taste or odor. We continued the regular treatments and detected no change in the condition until a week after a treatment which was given Oct. 8. At this time there was a distinct odor which was quite noticeable in the street adjacent to the reservoir and the surface of the water had an oily appearance. Another treatment was given Oct. 18, and conditions were much improved. The odor was eliminated and the latter was quite palatable. There were very few, if any, complaints because of the condition of the water. It is possible that only the water near the surface was affected and that none of the algae-laden water was drawn out into the distribution system. During this period, we were pumping 12 to 14 hours each day, not much water was used from the reservoir and the stored water did not reach all portions of the city.

Our serious trouble came during the holidays, when the consumption of water decreased considerably and we were not obliged to keep the pumps running full time to maintain the supply. After a shutdown of one day, complaints began to come in from all sections of the city. Some of the complaints were due to a taste of bleaching powder, but most of them were undoubtedly due to some other cause. The water in the reservoir looked good and tasted good. We therefore decided that the mains needed flushing. A very thorough flushing of the mains in a certain district south of the reservoir only increased the disagreeable taste and odor. A sample of water was then obtained from near the bottom of the reservoir and it had a very disagreeable taste. There was some ice in the reservoir, but this was broken up and the water was given a dose of one part copper sulphate (1 to 3,000,000 parts). This put the water in excellent condition again and all complaints ceased after flushing the mains thoroughly around the edge of the system to draw out the dead water in the mains.

Since our treatment of the reservoir was essentially the same in 1912 as during the four previous years when we had no indications of algae growths, we have been unable to explain satisfactorily the reason for this trouble. Perhaps the weather conditions were more favorable for such growths in 1912 than in previous years. Perhaps a water coagulated with sulphate of alumina is more susceptible to such growths than a water coagulated with sulphate of iron and lime. If this is true, we have probably found the reason, because we discontinued the use of the iron and lime treatment in March, 1912, and (with the exception of a few days) have used alum ever since. It is also quite possible that this trouble came from organisms in the river water, which found their way through the filters and eventually reached the reservoir. As we do not have the necessary equipment for making the microscopic examination, no attempt was made to identify any organisms. Our filter wash records for the year, however, indicate an unusual clogging of the filters from some cause, during the latter part of October, November, and the first 15 days of December. During a part of this period, the average length of time of operation between washes, was reduced over half and it was necessary to wash some of the filters, which contain fine sand, every three hours. During the five years covered by this paper the reservoir has been well stocked with fish. It is possible that the spawn is killed, but even the recent heavy dose of 1 part of copper-sulphate to 3,000,000 parts of water did not kill the fish. From our experience, we believe that we can safely increase the copper to 1 part in 4,000,000 parts of water.

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The Purchase of Street-Railway Power has been undertaken by the Cleveland (Ohio) Ry. Co., which is giving up the generation of its own electrical energy. It is under contract now to purchase 11,000-volts, three-phase, 60-cycle power from the Cleveland Electric Illuminating Co. This will be supplied to four substations equipped with rotary converters of special design, and storage batteries. The initial equipment of these stations will aggregate 15,500 kw. converter capacity with a possibility of increasing this to 25,000 kw. Graphical and numerical records are to be kept by the substation employees, and forwarded to the railway company's power department each day for totalizing. As an aid to efficient operation the substation records will also show plotted the capacity of machines running at each hour, so that it will be evident what approach is obtained to full load on the equipment in service.

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Screening the Sewage and factory wastes discharged into the "Bubbly Creek" arm of the Chicago River by the stock-yards and packing houses is to be tried as a means of avoiding the deposit of solid matter in the river and the drainage canal. Chemical and sedimentation treatment have been proposed by the Sanitary District of Chicago, in order to improve the character of the discharge from a sanitary standpoint, but at present only the screening will be tried. There will be two rotary screens of the Weand type; one will handle the sewage from four of the larger packing houses, and the other will handle that from the pens of the stock-yards This installation is experimental, and if it proves successful it is probable that all of the sewage will be treated in this way. No plans have been made as yet for the disposal of any large body of solid matter removed by the screens.

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*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association at Urbana, Ill., Mar. 11, 12, 1913.

†Superintendent, Citizens Water Works Co., Quincy, Ill.

The Wabash River Flood, March 21-April 2, 1913

By R. L. Sackett*

A series of heavy rains, extending over the entire drainage area of the Wabash River, commenced Mar. 21 and continued at intervals until Mar. 26, raising the river to unprecedented heights, causing the loss of many lives and the destruction of several million dollars of property.

Previous floods which did much damage occurred June 11, 1858, Aug. 5, 1878, Feb. 17, 1883, and Jan. 20, 1907. The flood just passed reached a mark 22 in. higher than the record of 1883 at Lafayette, Ind., and exceeded all records at Peru and Logansport by as high as 8 ft. The

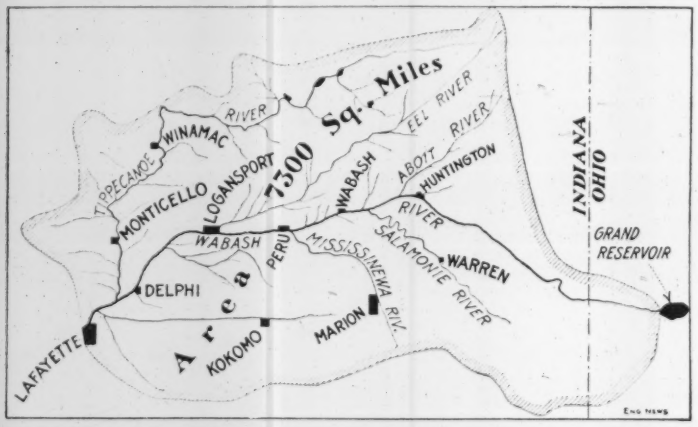

Fig. 1. Drainage Area of the Wabash River above Lafayette, Ind.

flood of 1883 was produced at Lafayette by an ice jam which formed about a mile below the city. The damage done was due to slack water, while the present flood caused the partial destruction of three large steel bridges by extraordinary erosion of the river bottom in the restricted sections.

One student lost his life in an attempt to rescue men marooned on the Brown St. levee, when the latter washed out on the west of them and the bridge fell on the east of them. High water closed the gas works, the two waterworks pumping stations, the city heating and lighting plant and many industries; one light and power plant continued in operation although its condensers and pumps were under 7 ft. of water.

The drainage area with its tributaries above Lafayette, as shown in Fig. 1, includes an area of about 7300 sq.mi., of which 400 are in Ohio. The whole of this area is in a glaciated area, the depth gradually decreasing east of this point until near Logansport, Ind., the bed of the river is in rock. East of that point the deposit varies in thickness.

The drainage area is practically clear of forests and under cultivation. The average fall of the river is about 18 in. per mile here and increases in the upper portions. There are numerous islands and sand bars which form and are swept away in periods of high water. The soil wash is high and the loss therefrom is a matter of great moment. The high turbidity is, of course, a factor in the erosive action which is so characteristic of the rivers of the Mississippi Valley.

The elevation of the head waters above M. H. T., New York harbor, is about 1000 ft; at Huntington, 699 ft.; at Logansport, 583 and at Lafayette, 500 for low water.

Rainfall data preliminary to the hydrograph, Fig. 3, are given in Table I.

TABLE I. RAINFALL DATA OVER WABASH RIVER DRAINAGE AREA
(Measured by Experiment Station at Purdue University)

Date	Inches
Average annual precipitation	50
Greatest annual precipitation, 1909	55
Greatest monthly precipitation June, 1902	11 37
Greatest precipitation in 24 hr., Aug. 12, 1912	4 30
Rainfall for March, 1913	7 05

The hydrograph shows a remarkable relationship between rainfall and runoff for a watershed of this area—7300 sq.mi. From Mar. 1 to Mar. 20 inclusive, only 0.94 in. of rain fell. From Fig. 3 it is apparent that according to the government rain gage at Purdue, and a private

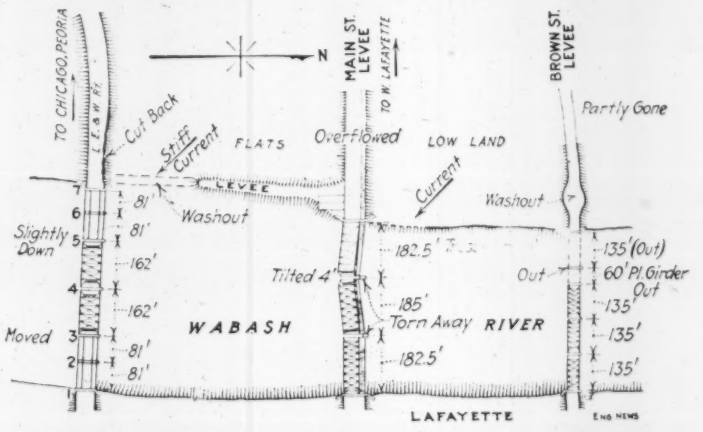

Fig. 2. The Three Bridges across the Wabash at Lafayette

gage, about 1 in. of water fell preceding the 23d, enough to thoroughly saturate the soil. On the 23d, 1.75 in. of rain fell; another inch on the 24th; 1.35 on the 25th-26th and snow on the 26th, which did not immediately melt. While there are no other rain gages on the watershed above this point from which records were obtainable, it is quite probable that the diagram represents average conditions. (See Table in Engineering News, Apr. 3, 1913, p. 381.)

The daily maximum temperature during the flood period is also shown on Fig. 3. While there had been no

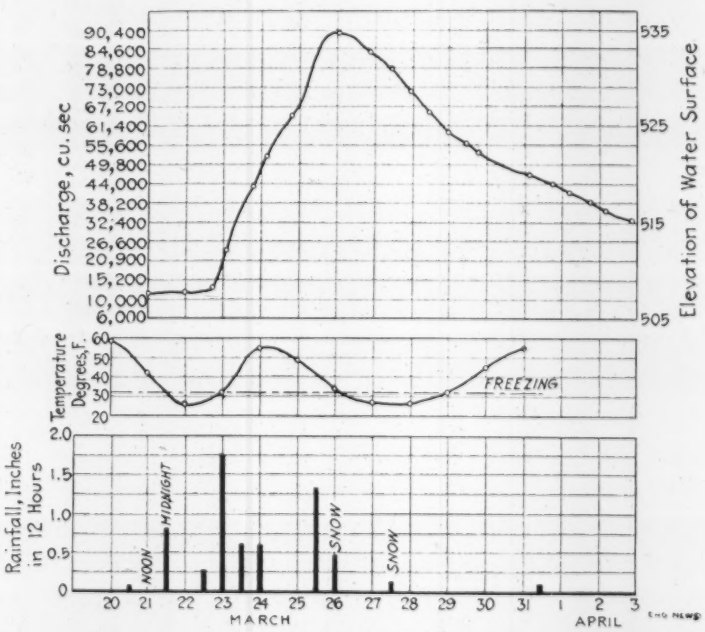

Fig. 3. Hydrograph of the Wabash River, Lafayette, Ind., Mar. 20—Apr. 2, 1913

*Professor, Sanitary and Hydraulic Engineering, Purdue University, Lafayette, Ind.

snow the saturated condition of the ground, which was free from frost, the temperature and the distribution of rainfall caused the highest known stage of the river.

Damage to Bridges

Fig. 2 shows the location of the three bridges at Lafayette, Ind., all of which suffered damage.

The upstream bridge, the oldest, was a through, highway, Pratt truss with a concrete-slab floor. Originally a covered wooden structure stood on these piers four spans of which were of about 135 ft. in length, but the

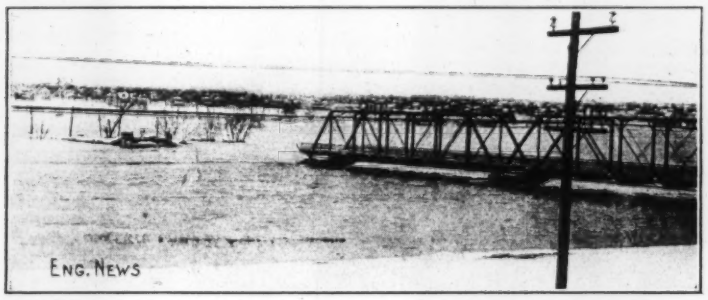

Fig. 4. The Brown St. Bridge from the East

second from the west was a short span originally designed to carry a jacknife type of open draw for steamboats. The pier on the west of the short span was washed out in the recent flood and the steelwork of one of the two spans destroyed now shows above the water lying parallel with the west bank and near it. The levee about one-half mile in length leading across the bottoms was overtopped Tuesday afternoon, Mar. 25, and two washouts occurred in it approximately 100 and 50 ft. wide.

The Main St. bridge approach on the west was of about the same height as the Brown St. levee but was paved with excellent sheet asphalt with a street-car track on the upstream side and a concrete walk on the south side. A hole was washed out at the foot of the hill in West Lafayette and the water flowed over the levee to a depth of several feet for almost its entire length. The Main St. bridge consists of three through Pratt trusses of 182.5, 185- and 182.5-ft. span and was built by the Lafayette

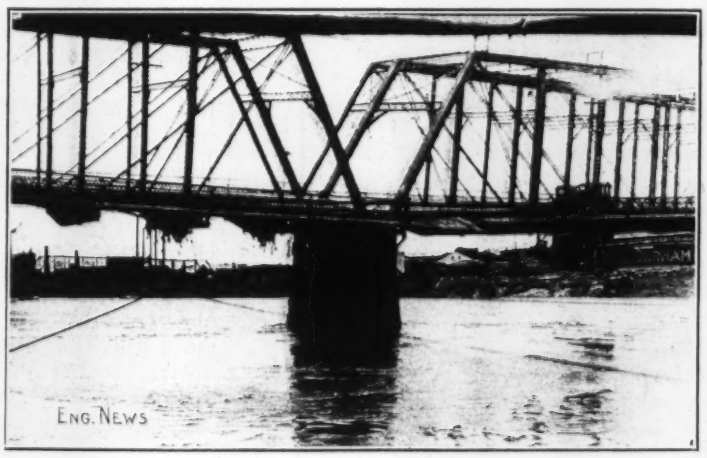

Fig. 6. Showing Settled West Pier

Engineering Co., 24 years ago. It has been neglected and as a result is badly rusted. Following the settling of the west pier, one counter and one diagonal of the top system failed. Each of them showed signs of old fractures.

The abutments and piers are built of a rather soft limestone and rest on piling reported by the inspector as being driven "from 12 to 16 ft. below low water." The masonry was later extended upstream to carry a light truss and street-car tracks. The new work was bonded to the old. In the fall of 1912, new wing walls were

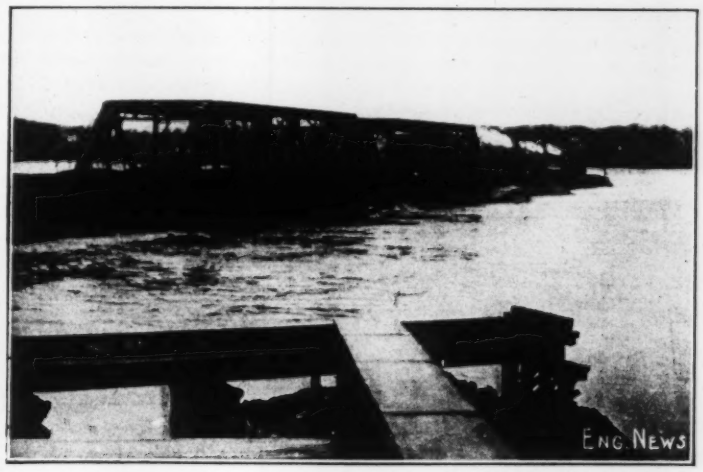

Fig. 5. The Lake Erie & Western Ry. Bridge at High Water, Mar. 26

built on the upstream side and the piers were extended the second time but with concrete. It was stated that the distance from top to street-car rail to bottom of piers was about 36 ft. The flood dislodged all of the concrete additions to the piers and these took with them a portion of the limestone masonry which formed the first first addition.

Soundings made Apr. 7, 1913, show that the depth from the top of the street railway rail to bottom of river is now 46.5 ft. on the west side of the west pier and 41.6 ft. on the east side at the upstream end and 51.5 ft. and 46.5 ft. respectively at the downstream end which is settled. At the east pier the corresponding depths at the upstream end are 46.6 and 40.6 ft. At the downstream end the corresponding depths are 46.8 and 41 ft. As the distance to base of masonry is 36 ft., and to point of piling not over 52 ft., the river bottom was eroded well below the bottom of the masonry.

Fig. 7. Showing Sag in Asphalt Paving

Figs. 6 and 7. The Main St. Bridge

After the Brown St. levee overflowed and was partly washed out, a strong cross-current formed, just above the Main St. levee, as shown in Fig. 2, which may have been a factor in the greater depth of erosion on the west side of the piers, except that such influence could not have ex-

tended to the middle of the center span, where the depth is 52.8 ft. or to the east pier, where the same difference in soundings occurs. The west pier of the Main St. bridge settled about three courses at the downstream end, very little at the upstream end. Now the downstream end is about 4 ft. below grade and the other end about at grade (see Fig. 6). The old masonry seems intact.

As the northwest end post was partly embedded in the new concrete wing wall, the west span swung on this point as a hinge, as the rumpled asphalt at the bridge portal shows in Fig. 7. The west pier has also listed to the west about 6 in.

On the south is the L. E. & W. Ry. bridge (Fig. 5), consisting of two through double-track riveted spans of 164 ft. each and four plate-girders of 82-ft. span, the old piers and abutments being used but extended upstream for the double-track bridge built in 1907 and the first piers from each end are new. A long fill, upgrade, leads to the west.

The fill was eroded by the strong current caused by the overflow of the Main and Brown St. approaches just above. The north track was undermined; for practically its width in places, but the railway forces were able to prevent the failure of the fill, which is made around an old timber trestle.

At the highest stage the water did not overflow the highway bridges above, although the tilted end of the Main St. span did rest in the water. The flood arose a few inches on the bottom chord of the railway bridge and banked against the plate-girders to a depth of 3 to 4 ft.

Loaded coal cars were kept on the north or upstream track continuously, and traffic was stopped from Tuesday till Friday, Mar. 28.

The water reached its maximum stage Wednesday about 1 p.m., and receded about one foot a day for a week following. No appreciable effect on the railway bridge was noticeable until after traffic was resumed. First, the track was found to have shifted down stream at pier 3 (see Fig. 2) about an inch. This continued to increase until it reached a maximum of 5⅝ in. on Apr. 5. This pier also began to settle and is now down 6 in. at the downstream end, and is above grade ⅜ in. at the upstream end. This end has varied its elevation slightly from time to time.

Piling is being driven at Pier 3 and falseworks will be placed under the through span adjoining. Chief Engineer Atwood of the L. E. & W. Ry. states that steel-sheet piling will be driven around this pier to prevent repetition of scouring.

The accompanying data (Table II) concerning the depth at the piers in 1907 and after the flood are of moment:

TABLE II

Depths from base of rail to river bottom

Pier No.	1	2	3	4	5	6	7
In 1907	31.3	40.75	41.0	41.5	39.4	30.2	17.7
After flood	37.0	44.65E	51E	38.0E	39.4E	38.4E	
		50.0W	47W	41.8	48.1W	38.5W	19.0

E indicates the East side of pier and W the west side. These data are from the Chief Engineer's Office.

The plans of the railway bridge show that at Pier 3 it is 43 ft. 11 in. from base of rail to bottom of masonry and 62 ft. 2 in. to point of piling. The pier is, therefore, entirely undermined and is supported by the piling alone. Pier 4 is 39 ft. 6 in. to base of masonry and 57 ft. 6 in. to point of piling. The other piers are of similar construction.

Soundings made by the writer on Apr. 7, show that the river bed is washed out between piers to even greater depths than those given in the table above. Between Piers 3 and 4 there are three depths of 50.49 and 48.5 ft. Between Piers 4 and 5 there are three depths of 49 ft. each, measured from base of rail. From the data at hand it seems no exaggeration to say that the bottom of the river has been excavated here nearly ten feet.

The river bends slightly here and the current swings slightly toward the east shore. At flood stage a strong current swept out of the bottoms just above the railway fill and helped to cause the marked erosion on the west side of Piers 5 and 6. Pier 4, in midstream, seems to have been least affected by the scour.

The railway telegraph and telephone cables fell and quantities of débris lodged against the plate-girders, partly held perhaps by the cables, which deflected the currents downward and caused the extraordinary erosion.

The river was a half-mile wide on the average except when restricted. At the Brown St. (Fig. 4) bridge the clear waterway, between abutments, was about 560 ft.; at the Main St. bridge about 520; and at the railway bridge about 600 ft. The maximum discharge was near 100,000 cu.ft. per sec., and the surface velocity about 10 ft. per sec.

The flood was not caused by an unprecedented rainfall but by a conjunction of conditions, as stated in your editorial of Apr. 3, 1913, and may easily recur, once in ten or twenty years. "Rainfall came at a time when the ground was well saturated by previous rains and at a time of year when evaporation is nil."

The Lake Erie and Western Ry. has nearly completed driving its piling and will soon have traffic in motion. Pier 3 will be entirely rebuilt. No move has yet been made toward repairing or rebuilding the Brown St. or Main St. bridges. Traffic is at present dependent upon ferries.

If a repetition of the present conditions is to be met it would seem necessary to increase the width of waterway by another span at the Main St. bridge and correspondingly at the railway bridge.

Soundings and gagings have been taken at a section of the Wabash River above the Brown St. bridge for six years by students in the Civil Engineering College, at Purdue. There is nothing to indicate any general changes in the river bottom where it is not restricted, other than might be expected in a river of this type. It is not probable that soundings soon to be made will indicate any such general deepening of the river as has occurred beneath the bridges.

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Accidents in Metal Mines of the United States have been studied by A. H. Fay, mining engineer of the U. S. Bureau of Mines. He reports that of the 165,979 men employed during the calander year 1911, 695 were killed, representing a rate of 4.19 per 1000, as compared with 3.73 per 1000 for the coal mines of the country in the same period. The serious injury cases amounted to 4169, or 25.12 per 1000 persons, and the slight injuries were given as 22,408, or 135.01 per 1000. Of the total fatalities, 532 were underground (at the rate of 5.18 per 1000 persons) and 153 were on the surface (at a rate of 2.49 per 1000). Of the fatal accidents, 32.5% were due to falls of ore or rock from roof, wall or bank; 11.23% were due to explosives, 15.39% to falling down stopes, shafts or winzes, and 5.32% to fire. Of the serious accidents, 28.86% were due to falls, 19.05% to car and hauling systems, 12.19% to machinery, and 6.41% to timbers and hand tools. Among the slight accidents, 28.86% were due to falls, 15.52% to car and hauling systems, 7.10% to machinery, and 8.02% to timbers and hand tools.

Proposed Highway Bridge and Highway Tunnels across the Hudson at New York

Public agitation for a number of years past on the subject of highway communication across the Hudson River, and the resulting appointment of commissioners by the states of New York and New Jersey to form a joint commission for studying the subject of bridges and more recently also the subject of highway tunnels have finally produced the recommendations and designs noted below. Boller, Hodge & Baird, as consulting bridge engineers to the commission, studied the subject of bridge location and made designs for bridges; Jacobs & Davies, Inc., similarly dealt with the subject of tunnels.

Prior reports on bridges by the Interstate Commission were based on tentative recommendations from its engineers, which recommendations involved the assumption that suitable foundations could be obtained in the river channel for spans of moderate length. Subsequent borings proved that foundations in the channel could not be had, as rock was at unattainable depth; this made it clear that long spans exceeding 2000 ft. would be necessary. Under these circumstances the engineers changed their earlier recommendation for a bridge at 179th St. (Fort Washington Point) to a location at 57th St., and worked out the design shown by the sketch drawings (Figs. 1 and 2) herewith, for this particular location.

The subject of tunnels naturally comes up for consideration in this matter because the great bulk of the vehicle traffic between New York and New Jersey across the Hudson is carried on at the lower part of the city several miles south of 50th St. At any southerly location, however, a bridge is practically out of the question as the shores are low. The commission, therefore, recently took the question of building one or more highway tunnels, instead of a bridge, under serious consideration. The successful operation of highway tunnels in London, Glasgow, and Hamburg, and the completion and successful operation of several railway tunnels across the Hudson River at locations between Cortlandt St. and 32d St. remove doubt as to the engineering practicability and operating feasibility of highway tunnels through the Hudson silt.

The magnitude of the vehicle traffic across the Hudson River is often not appreciated. A very heavy freight trucking intercourse goes on between lower New York and New Jersey, using the existing railway ferry lines. The most northerly ferry, that at 130th St., Manhattan, to Edgewater, N. J., carries chiefly automobile traffic. A traffic census shows that about 6,000,000 vehicles cross the river per year. The distribution among the different ferries is as shown by the accompanying table. In comparison, the Rotherhithe highway tunnel under the Thames at London (ENGINEERING NEWS, Dec. 19, 1907) carries about 1,000,000 vehicles per year, and the Blackwell tunnel about as many.

Incidentally it may be noted that about 158,000,000 passengers cross the Hudson River per year, counting those carried by ferries and those going through the Hudson & Manhattan and Pennsylvania tunnels.

To accommodate the trucking traffic, which is vital to the commercial life of the New York and New Jersey communities, a tunnel in the southern part of the city would unquestionably be of far greater utility than a bridge in an uptown location. The New Jersey Interstate Bridge and Tunnel Commission, in reporting to the Legislature of the State of New Jersey, has therefore reported that it considers the construction of both a bridge and a pair of tunnels necessary:

> Your commission has thoroughly investigated the feasibility of building and operating tunnels for vehicular traffic and is satisfied that this method of connecting highways of this state with the city of New York is practicable and the most economical for the section south of 50th St. in New York.
>
> Your commission is also satisfied that the construction of a bridge at about 58th St., New York, to a point on the Palisades in the town of West New York, is a necessary improvement for the accommodation of vehicular and trolley traffic, connecting that section of New York with the northerly part of the county of Hudson, and the county of Bergen, and serving also a large portion of the counties of Passaic and Essex. This would also connect the city of New York with that portion of the state of New York lying west of the Hudson River.
>
> The preliminary estimate of Boller, Hodge and Baird, the engineers on bridges, shows that the construction of such a bridge with a single span of about 2800 ft., with a width of 204 ft. and a height above the river of 170 ft., and accommodating all classes of vehicular traffic as well as trolley, subway, elevated railroad and foot passengers, would cost $42,000,000.
>
> The estimate of Jacobs and Davies of the cost of construction of a pair of tunnels, one tunnel for westbound and one for eastbound traffic, providing for slow-going and more rapid-moving vehicles, would cost $11,000,000.
>
> Your commission is, therefore, satisfied that both tunnels and a bridge are practicable and necessary to provide for the vehicular traffic which is constantly growing between the points mentioned.

PROPOSED 57TH ST. BRIDGE

As the drawing Fig. 1 shows, rock has been found at the sites selected for piers and anchorages of the 57th St. bridge. The depth of rock surface below mean high water at the main piers is 180 ft. in the maximum. In view of the general subsoil conditions along the river Hudson, this is a fortunate circumstance and makes the construction of suitable foundations for a large bridge appear quite practicable. The topography of the two shores is such that, with river clearance 170 ft. at midchannel, the ground on the New York side can be reached with an approach of moderate length at a gradient of 2.48% while the New Jersey side involves no grade, as a level approach would lead directly to the top of Bergen Hill.

The unprecendented span, 2880 ft. center to center of piers, led the engineers to select a wide bridge with large traffic capacity as being the only justifiable construction under the circumstances. They have provided for two four-line roadways, two sidewalks, and eight lines of railway track, these latter being intended for trolley car and rapid transit service. Stated in terms of load, the design

VEHICLE TRAFFIC OVER HUDSON RIVER FERRIES AT NEW YORK CITY

Ferry	Average vehicles per day
Fort Lee—Edgewater to 130th Street	816
Weehawken to Cortlandt and 42d Street (West Shore R.R.), divided about equally between Cortlandt and 42d Streets	2,536
Hoboken Ferry—14th Street to 23d Street (D. L. & W. R. R.)	1,400
Ferry Street, Hoboken, to Barclay, Christopher and 23d Streets (D. L. & W. R. R.)	4,206
Pavonia Avenue, Jersey City, to 23d and Chambers Streets (Erie R.R.)	2,995
Exchange Place, Jersey City, to Desbrosses and Cortlandt Streets (Pennsylvania R.R.)	5,207
Communipaw to 23d and Liberty Streets (C. R. R. of N. J.)	2,500
Total per day (both directions)	19,660
Total per month 25 days	491,500
Total per year 300 days	5,898,000

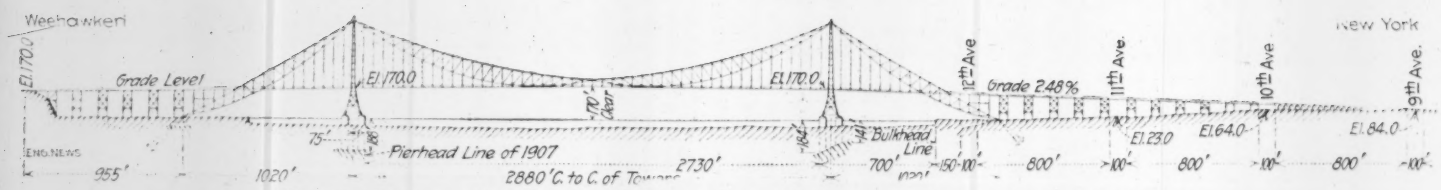

FIG. 1. DESIGN FOR HUDSON RIVER BRIDGE AT 57TH ST., NEW YORK CITY
(Boller, Hodge & Baird, Consulting Engineer.)

has been made for a loading of 20,000 lb. per lin.ft. of bridge. The width of the deck is 204 ft.

The suspension type was chosen for the supporting structure of the bridge and instead of a cable design the Lindenthal eyebar design for the Manhattan Bridge (described in ENGINEERING NEWS, Feb. 26, 1903, p. 183, *et seq.*; not built) was followed closely. The towers are of steel. Both the tower construction and the suspender arrangement are indicated in a general way in the drawing Fig. 2.

The bridge is located with axis halfway between 57th and 58th Sts., New York City, and on the center line of 6th St., Weehawken. For the New York approach, which is the critical one, it is proposed by the engineers that the block between 57th and 58th Sts. from the river front to Ninth Ave. be acquired and cleared of buildings to accommodate the bridge approach, leaving the space under the approach to be utilized for various public purposes subsequently.

The total estimated cost of the bridge is tabulated below. The time of construction is estimated at six years.

ESTIMATED COST OF 57TH ST. BRIDGE

River span and anchor spans	$27,100,000
Approaches	1,900,000
Total structure	$29,000,000
Engineering contingencies	2,900,000
Real estate	4,800,000
Interest during construction	5,300,000
Total cost	$42,000,000

As already stated, the report of the bridge engineers is based on a series of borings which were made during January and February of the present year at the direction of the bridge commission. Water-jet wash borings were put down to rock and diamond-drill core borings put 10 ft. in the rock as assurance that bedrock and not boulders had been struck. Four borings were made on the site of the New York pier, four on the site of the New Jersey pier and six at the site of the New Jersey anchorage. These borings showed that rock is from 176 to 184 ft. below mean high water at the New York pierhead line, sloping up to 134 ft. and 141 ft. at 150 ft. back of the pierhead line, while at the site of the New Jersey main pier the surface of bedrock is practically horizontal at 187 ft. below mean high water. At the site of the New Jersey anchorage also satisfactory bottom for the anchorage was found. On the New York side the anchorage would come practically on surface rock.

CANAL STREET HIGHWAY TUNNEL

The sketch design of Jacobs & Davies, Inc., for highway tunnels under the Hudson River is shown by Fig. 3. These are 30-ft. iron-lined shield-driven tunnels, preferably built as a pair, giving one tube for eastbound and one for westbound traffic. The size of tunnel is practically the same as that of the Blackwall and Rotherhithe Tunnels in London, respectively 4470 ft. and 5200 ft. long between portals (6200 ft. and 6883 ft. with approaches), but the English tunnels are single tubes carrying traffic in both directions.

The difficulty of ventilation has been urged against highway tunnels. The Blackwall and Rotherhithe Tunnels, however, are operated without artificial ventilation although the former was fitted for ventilation; their operation is not found objectionable. In the present case, however, the engineers recommend providing ventilating ducts and ventilating machinery.

The question of best location for highway tunnels was studied with considerable care. The location finally selected is described in the following:

In view of the requirements of the traffic and the physical conditions, we recommend as a location for the first tunnels a line from the foot of Canal St., Manhattan, to intersect the shore line of Jersey City at approximately the extended line of 12th Street, Jersey City, which is the line of division between the properties of the Erie and Lackawanna Railroads, and extending thence to a portal in the block between 12th and 13th St. and Provost and Henderson St., so that the surface of the street is reached at Henderson St., which is the first continuous street parallel to the river connecting Jersey City and Hoboken. This location will not interfere with the various projected rapid-transit tunnels or subways; or with the developments and improvements con-

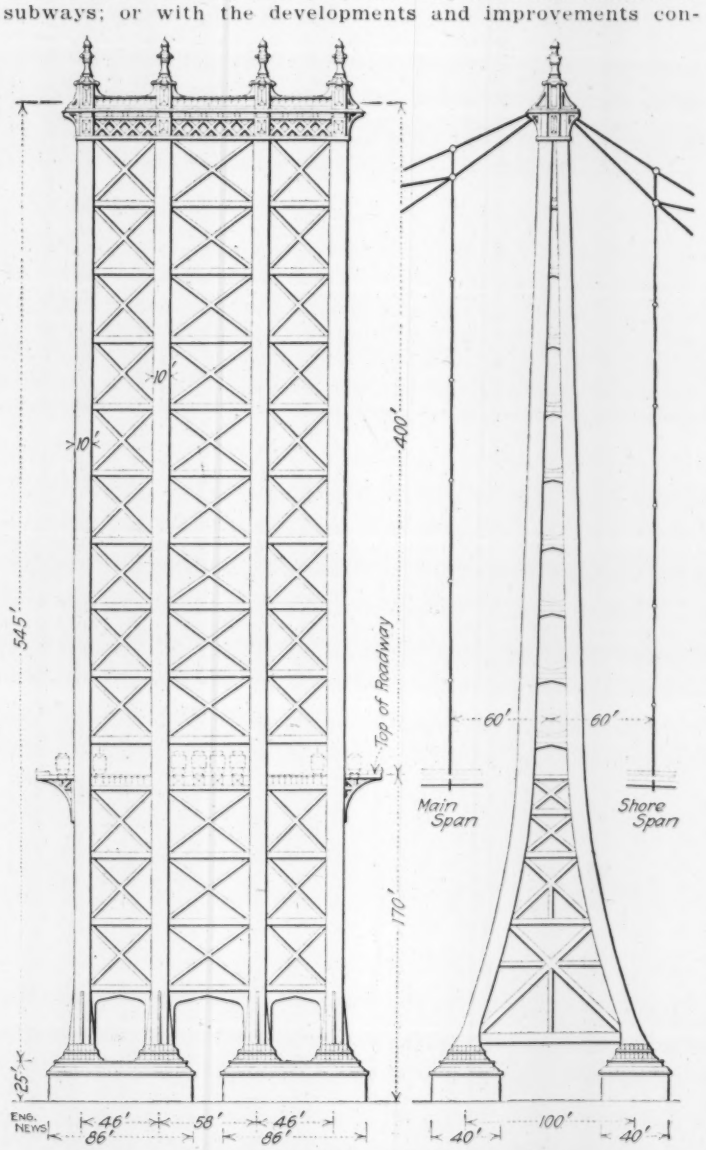

FIG. 2. TOWER OF HUDSON RIVER BRIDGE

templated by the railroads or by the cities; and will not obstruct or interfere with public streets or private property other than in its outlet upon Canal St., where the widening of the street for one block would be necessary. The approach would reach the grade of the street at the line of the new extension of Seventh Ave., and widening of Varick St. This location permits of direct connection along Canal St. to the Manhattan Bridge and is in close proximity to the Williamsburgh and Brooklyn Bridges; to the new 1000-ft. steamship piers; and to the main arteries to uptown Manhattan. Canal St. is the widest crosstown street in the downtown district, and its surface is also the lowest, making the approaches shorter than they would be in any other street. The maximum adverse gradients eastbound would be 3.7% and westbound 3%, these being practically the same rates that prevail on the East River bridges.

On the New Jersey side this location gives immediate access to either the low sections of Jersey City and Hoboken or to Jersey City Heights by the 13th St. viaduct. There is consequently no reconstruction of any of the highways in New Jersey required to give access to this tunnel. This location is in immediate proximity to all railway yards and freight stations, to the warehouse and manufacturing district, and to the steamship piers.

The cost of the pair of tunnels located and constructed as described is estimated at $11,000,000. This includes

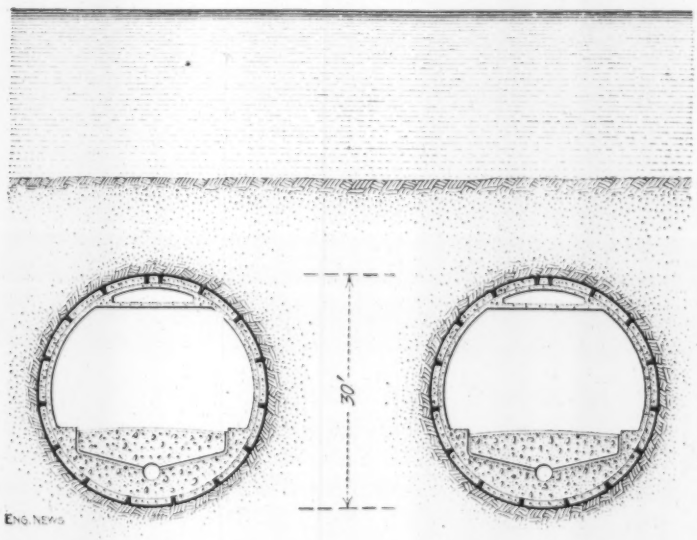

FIG. 3. SKETCH OF DESIGN FOR PAIR OF HIGHWAY TUNNELS UNDER HUDSON RIVER AT CANAL ST., NEW YORK
(Jacobs & Davies, Inc., Consulting Engineers.)

cost of right-of-way, cost of approaches, interest during construction, engineering and contingencies. A time of three years is set for the construction, with the possibility of doing the work in materially less time.

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Tests of a Diesel Engine, built by the Busch-Sulzer Bros. Diesel Co., of St. Louis, Mo., for the Hugo, Oklahoma, Ice & Light Co., were recently made by A. T. Scott, of Dallas, Tex. The engine is a three-cylinder machine rated at 225 net b.hp. direct connected to a generator. The fuel consumption in various rates of output was as follows:

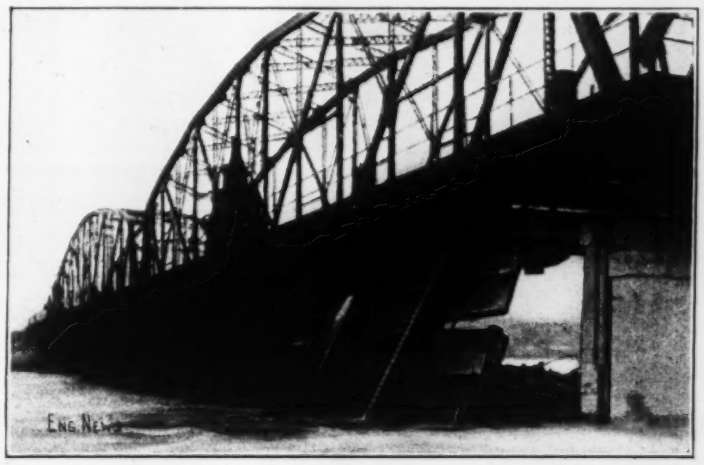
Net brake hp.	Oil burned per net brake hp.-hour, lb.
49.7	0.769
111.39	0.482
162.97	0.454
219.63	0.441
245.6	0.444

The air compressor furnishing the air for starting the engines and injecting the fuel supply was driven by power from an independent source. The current used to drive this compressor was deducted from the output of the generator to obtain the net brake horsepower. The engine tested had been in operation for six months. The oil used showed on analysis 18,986 B.t.u. per lb. of oil; the specific gravity was 0.8531 and it had a viscosity at 92° F. of 1.63. Analysis of the exhaust gases showed that no combustibles remained in them. A complete report of the tests has been issued by the builders of the engine.

Damage to Movable Dam, Yosts, N. Y.

Between Little Falls and Schenectady the Mohawk River, as canalized for the New York State Barge Canal, is provided with eight movable dams, the gates of which can be raised in times of high water to prevent structural damage and overflow of adjacent land by excessive pondage. These dams were described in ENGINEERING NEWS, Dec. 8, 1910, p. 611, where views of two dams and complete structural details may be found. Briefly, the type of dam adopted consists of a series of ordinary bridge trusses, upon concrete piers, carrying, hinged from the downstream lower chord, a series of steel frames which swing down into the river and there butt against concrete and cast-iron blocks embedded in the concrete paving of the river bottom. On these frames are lowered two sets of gates, an upper and a lower, to control high or low flow as needed. The gates are controlled by small hoists which travel back and forth across the bridge.

Dam No. 9 of this type of dam, across the river at Yosts, N. Y., consists of two spans. The gates were down during the night of Mar. 26 and the rising flood



MOVABLE DAM NO. 9, AFTER RECENT FLOOD OF MOHAWK RIVER

brought down so much drift which lodged against them, that it was impossible in the morning to raise the hanger beams, though it appears that the gates themselves were raised sufficiently to let some of the flood water pass under them. The drift continued to accumulate against the hangers and the pressure became so great as to force some of the hangers back out of vertical and to twist and strain the cross-bracing. One set of hangers (two hangers with cross-bracing) was so badly twisted that the attendants drove out the hanger pins and the set was allowed to drop down into the river, but on the whole the damage was not as great as at first reported.

While the river is still too high to permit of a thorough investigation, it is thought that the hanger beams did not buckle, but that rather they lifted by moving along the slotted hole provided for the hanger pins, and were thus allowed to slide over the buffer blocks in the river bed.

The accompanying view, taken on Mar. 28, after the water had receded about 3 ft., shows the bent hangers on the north span.

So far as can be learned, none of the other similar bridge dams on the Mohawk were injured by the high water in the recent flood.

FIELD AND OFFICE

Pole-Truss Highway Bridges on Mountain Roads in Washington

By C. R. Ege*

In order to eliminate some dangerous fords of the American River and one of its small tributaries, the State Highway Commission of Washington built five small bridges on State Road No. 1, in Yakima County. As only a small expenditure was justifiable, and the cost of freighting material from the railroad at Natches was very high, the haul being from 40 to 47 miles, it was decided to build small combination trusses, using for the wood members hewed timbers which could be secured from the forests along the river.

FIG. 1. A 60-FT. SPAN POLE-TRUSS BRIDGE, YAKIMA COUNTY, WASH.

A contract was accordingly let for one 40-ft. span, three 60-ft. spans, and one 75-ft. span, at the following prices:

Timber in place	$60.00	per M. ft. b.m.
Steel, wrought iron and spikes, in place	0.09	per lb.
Rock filling for log-crib abutments	1.60	per cu.yd.

No special plans for the work were drawn, but standard plans and specifications were used which were drawn up for the construction of similar bridges at points where sawed timber was available. The clause in the specifications covering the use of round or hewed timbers reads as follows:

> Round or hewed timbers may be used when specified by the Highway Commissioner, and shall be of cross-section equal to that of sawed timber shown on the drawings, exclusive of sap or wane.

The specifications covering quality and defects were the same as are applied to sawed timbers for structures of this class.

FIG. 2. A VIEW OF A POLE-TRUSS BRIDGE, SHOWING AVAILABLE TIMBER FOR BUILDING

The bridges were designed for a uniform load of 80 lb. per sq.ft. of floor surface, and the working stresses for timber, in lb. per sq.in., were taken as follows: tension, with the grain, 1200; compression in end bearing 1400, in columns under 15 diameters 1000, across the grain 350; transverse fiber stress, 1200; shearing with the grain 150, across the grain 1250.

The 40-ft. span was carried by two king-post or A-trusses, made of sticks equal in size and strength to 12x12-in. timbers. The bottom chords were single sticks. A 12x14-in. floorbeam at the center of the span was car-

*Chief Draftsman, Washington State Highway Commission, Olympia, Wash.

ried by two 1-in. round rods in each truss, which took bearing on a ½x6x12-in. plate at the apex of the truss. The floorbeam was extended 5 ft. beyond the trusses and 350; transverse fiber stress, 1200; shearming with the trusses to support them laterally.

The 60-ft. spans were 3-panel queen-post trusses, similar in design to the 40-ft. span, except for counterbraces in the center panel. The bottom chords were single

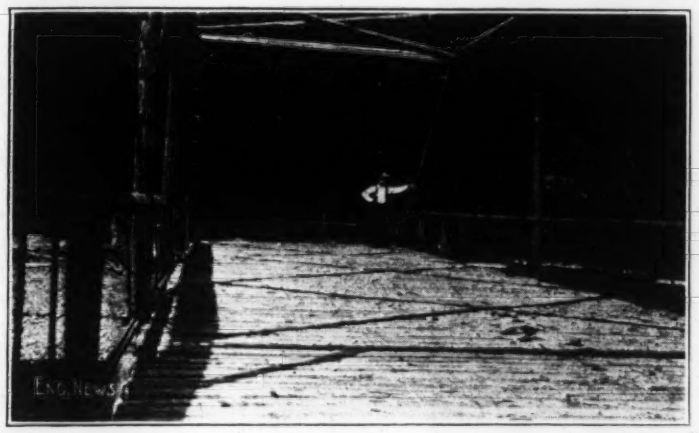


FIG. 3. DETAILS OF A 75-FT. SPAN, POLE-TRUSS HIGHWAY BRIDGE

sticks 68 ft. over all. These were cut and dragged into place by teams so as to span the river between the abutments, and the light staging to carry the upper chords during erection was carried by these sticks.

No castings were used at the joints in either the 40- or 60-ft. spans. The timbers were cut to bear on each other evenly and make an exact joint, the line of the joint bisecting the angle between adjacent members. The end posts transferred the thrust to the lower chords through scarf-joints, reinforced by thrust-blocks bolted to the lower chord over the end bearings.

The 75-ft. span was a 5-panel Pratt truss, with steel eyebars for the lower chords, and rigid upper and lower lateral bracing. Standard Howe-truss castings were used at the joints. The timbers were cut to exact length, peeled and left round except at the joints where they were adzed to exact dimensions to fit the castings. Falsework staging was anchored to each abutment and built out into the river far enough to carry one panel, reducing the span for erection to about 40 ft.

The bridges have 14-ft. roadways, with 4-in. hewed plank floors, and railings of light smooth poles spiked to the end posts and verticals. The floor stringers were peeled logs, flattened on two sides to a minimum thickness of 12 in. Four such stringers carried the roadway. The abutments were rock-filled log cribs.

The contractor sublet the work of getting the timber out of the forests at 6c. per lin.ft., for sticks peeled only; and at 8c. per lin.ft. for sticks peeled and hewed.

A skilled workman can fell, peel, and hew about 90 lin. ft. of timber per day of 8 hours. The workmen were paid 5c. per lin.ft. for felling, peeling and hewing. Laborers and carpenters on the framing and erection received $3 and $3.50 per day; teams and drivers cost $7 per day; the foreman received $6 per day. The price paid for freighting materials from the railroad at Natches was $0.56 per ton-mile.

The quantities of material and costs at the contract prices for these bridges, exclusive of abutments and earth approaches, were as follows:

One 40-ft. span:	
7900 ft. b.m. of timber at $60 per M	$474.00
290 lb. of metal at $0.09 per lb	26.10
Total	$500.10
One 60-ft. span:	
12,360 ft. b.m. of timber at $60 per M	$741.60
780 lb. of metal at $0.09 per lb	70.20
Total	$811.80
One 75-t. span:	
13,700 ft. b.m .of timber at $60 per M	$822.00
5,540 lb. of metal at $0.09 per lb	498.60
Total	$1320.60

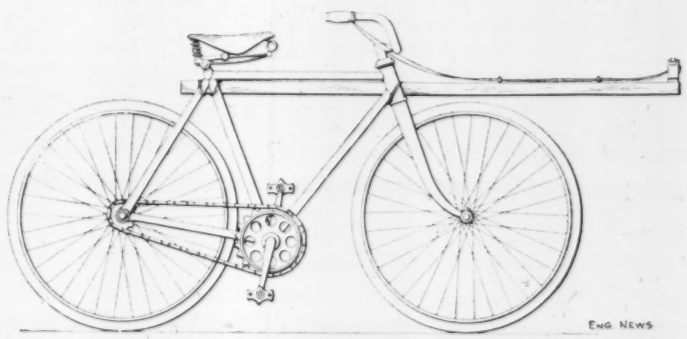
Will T. Cavanaugh was superintendent for the contractor, J. W. Quigg & Co., of Wenatchee and Tacoma. The work was commenced under the direction of Highway Commissioner Henry L. Bowlby, and was completed by his successor, W. J. Roberts, the present Commissioner.

Method for Calibrating Anemometers

BY E. F. LEARNED*

A method of calibrating an anemometer, which was used in connection with recent tests of a heating and ventilation plant, consisted in attaching the instrument to a projecting support on a bicycle and in riding the wheel over a definitely marked course at different rates of speed.

A piece of wood 1 in. thick, 3 in. wide and about 8 ft. long was fastened horizontally to the frame of the bicycle, as shown in the accompanying figure, with the forward end projecting about 5 ft. beyond the wheel. The anemometer was attached to an upright block screwed on to the outer end of the board and was far enough in advance of the wheel not to be affected by the air eddies caused by the rider and machine in motion. Two strong



BICYCLE RIGGED FOR CALIBRATING ANEMOMETER

threads fastened to the starting lever of the instrument were carried back along the top of the board through wire loops to the handle bars, thus enabling the rider to start and stop the anemometer at will.

An exhibition hall was used as the place for the tests. A chalk line about 280 ft. long was drawn on the floor and two short lines, 200 ft. apart, were laid out at right angles to the main line. One of these, placed about 40 ft. from the end, served as the starting point and the other was the finish of the measured course. All windows and doors were closed permitting the calibrations to be made in still air.

The bicycle was started at the end of the chalk line, which was sufficiently distant from the starting point to enable the rider to maintain the wheel at uniform speed

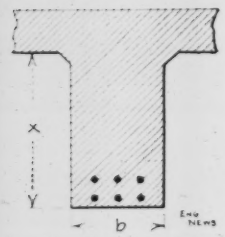
*33 Irving St., Watertown, Mass.

before entering the 200-ft. course. At the instant of crossing the mark, an assistant took the time by a stop watch and the rider pulled one of the threads thereby starting the registering mechanism of the anemometer. When the finish line was reached the time was taken by the assistant and the mechanism stopped. The course was covered in both directions and the average time taken, thus eliminating errors due to the possible movement of the air in either direction. The observations for different speeds were recorded in tabular form with the following headings: (1) time in seconds, (2) anemometer readings, (3) anemometer velocity in feet per minute, and (4) true velocity in feet per minute. A chart was made with anemometer readings in feet per minute as abscissas, and true velocities in feet per second as ordinates. A line was drawn through the points representing the conditions as equitably as possible. This method can be easily followed when a large hall or building with a sufficient amount of floor space is available.

Economical Depth of T-Beams

By R. W. Stewart*

The writer submits below the criterion for economical depth of reinforced-concrete girders in slab-and-girder construction, which, as will be noted, is very easy to apply.



Let the accompanying figure represent a section at the center of a T-beam which has been correctly reinforced to resist a given bending moment. It is desired to know whether an increase or decrease in the depth of the stem, with the corresponding change in the size of the steel rods, would result in economy.

It is evident from the shape of this beam that a change in the depth of the stem would have very little effect on the position of the center of gravity of the compressive stresses, and that the distance from the steel rods to the center of gravity of the compressive stresses will always be nearly equal to the depth of the stem of the beam.

Since the quantity of concrete in the stem of the beam varies directly as the distance x, the cost of concrete in the stem for any depth may be represented by gx, where g is a constant and x is a variable. Since the area of the steel varies inversely with x, its cost may be represented by $\frac{a}{x}$ where a is a constant. The total cost of the stem of the beam is then represented by the equation:

$$\text{Cost} = gx + \frac{a}{x}$$

To determine the value of x, which makes this cost a minimum, put the first derivative equal to zero or,

$$g - \frac{a}{x^2} = 0$$

from which we get $x = \sqrt{\frac{a}{g}}$.

Substituting this value of x in the equation for the cost above, we get for the cost of the steel $\frac{a}{\sqrt{\frac{a}{g}}}$ which reduces to $g\sqrt{\frac{a}{g}}$, which, it will be noted, is equal to the cost of the concrete.

The criterion for minimum cost is, therefore, that the *cost of the concrete in the stem shall be equal to the cost of the longitudinal steel.* The cost of the vertical legs of the stirrups should be included as part of the cost of the concrete in the stem.

It will occur in connection with this criterion that for buildings of several stories it will be desirable to use a lesser depth of girders than that given above in order to reduce the total height for a given clearance between floors and ceilings. Provision for this feature is readily introduced into the criterion by simply adding to the cost of the concrete stems of all the T-beams under consideration the cost of a portion of the walls and partitions of the building equal in height to the stem depth of the T-beams, the criterion then being that this sum shall equal the cost of the longitudinal steel in the T-beams.

In order to apply this criterion conveniently in working out a design it is necessary to determine the values of the constants a and g in the equation: Cost $= gx + \frac{a}{x}$ in terms of known functions of the beam.

Let

M = Bending moment;
A = Area of steel;
f_s = Fiber stress in steel;
b = Width of stem;
c = Cost per cubic unit of concrete;
q = Cost per cubic unit of steel;
$r = \frac{q}{c}$.

Cost of stem concrete per lineal unit of beam is

$$cbx = gx$$

from which

$$g = cb.$$

Bearing in mind that the lever arm of the steel about the center of gravity of the compressive forces is substantially equal to x, the area of the steel

$$A = \frac{M}{xf_s}$$

And the cost of the steel per lineal unit is

$$qA = \frac{qM}{xf_s}$$

Equating this to $\frac{a}{x}$ we get

$$a = \frac{qM}{f_s}$$

Using these values of a and g in the general equation

$$x = \sqrt{\frac{a}{g}}$$

we get

$$x = \sqrt{\frac{qM}{bcf_s}} = \sqrt{\frac{rM}{bf_s}}$$

This equation is given in Turneaure & Maurer's treatise

*Engineer of Bridge Department, Los Angeles, Calif.

on reinforced concrete, being derived by a different method.

To compute the ratio r, the same unit of volume must be used for both the steel and the concrete, but not necessarily the same unit in which d, x and M are expressed. Since r and f_s for any particular design remain constant, the value of $\frac{r}{f_s}$ may be determined and treated as a single constant quantity for the work in hand, so that when the bending moment in the beam has been found, the economical depth is given by a single setting of the slide-rule.

In order to include the effect of walls and partitions in the formula $x = \sqrt{\frac{r\,M}{b f_s}}$ first determine the total horizontal area covered by the stems of the T-beams under consideration and the total horizontal sectional area of the walls and partitions at the level of the beams.

If the cost per cubic foot of the walls is greater or less than the cost per cubic foot of the T-beam stems increase or decrease their area in proportion to the difference in cost. Then increase the cost per cubic foot of the T-beam stems in the ratio which the total corrected area bears to the area of the T-beam stems in order to obtain the unit cost c which is used to determine the ratio r. Also the cost per cubic unit of the steel should be corrected to provide as nearly as possible for excess length of the rods due to laps and bends.

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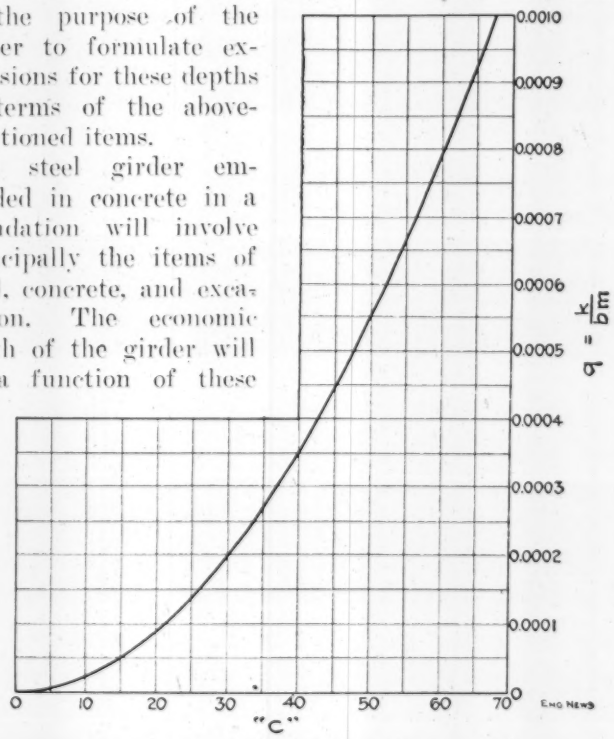
Economical Design of Steel Girders Embedded in Concrete

By George Paaswell*

In the design of subsurface structures, the economic depths of embedded steel girders are dependent upon the costs of excavation, concrete, steel shapes, etc.; and it is the purpose of the writer to formulate expressions for these depths in terms of the above-mentioned items.



A steel girder embedded in concrete in a foundation will involve principally the items of steel, concrete, and excavation. The economic depth of the girder will be a function of these items as well as of the required section modulus.

The items of concrete and excavation will vary together since an increase in the amount of concrete required (due to an increased depth of girder) will involve the same increase in the amount of excavation required. Hence the individual costs per cubic yard of concrete and excavation may be added and one price used. If concrete alone is involved this price will be the price of concrete; likewise if excavation alone is involved.

Let

S = Required section-modulus of girder;
d = Depth out to out of girder;
A = Area of girder;
r = Radius of gyration;
I = Moment of inertia.

Now

$$S = \frac{2\,I}{d} = \frac{2\,A\,r^2}{d}$$

and

$$r \text{ (approximately)} = 0.4\,d$$

Hence

$$S = 0.32\,A\,d \text{ or } A = \frac{3.13\,S}{d}$$

Taking a depth of concrete and excavation of d a width of b and a length of one foot the item involved in cubic yards will be

$$\frac{b\,d}{12 \times 12 \times 27} = 0.000257\,b\,d$$

The amount of steel will be $3.4\,A = \frac{10.63\,S}{d}$; adding 10% for details the total amount $= \frac{11.69\,S}{d}$.

Let

k = Cost of steel in cents per lb.;
m = Cost of concrete and excavation in cents per cu.yd. (or of either if the other is not involved).

The total cost of steel concrete and excavation is then:

$$\frac{11.69\,S\,k}{d} + 0.000257\,m\,b\,d$$

To obtain a minimum value of this expression equate the derivative to zero:

$$\frac{11.69\,k\,S}{d^2} = 0.000257\,b\,m$$

$$d = 213\sqrt{\left(\frac{k\,S}{b\,m}\right)}$$

Let $q = \frac{k}{b\,m}$ then $d = 213\sqrt{q\,S}$.

Let the constant $213\sqrt{q} = c$ then $d = c\sqrt{S}$.

A curve is shown herewith giving the value of c for various values of the ratio $\frac{k}{b\,m}$.

Needless to state the slide-rule gives sufficiently accurate results.

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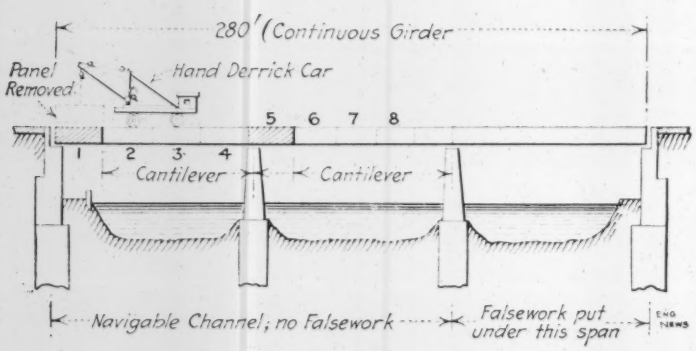
The Dictagraph in Aviation—According to a recent note in the "Army and Navy Gazette," a new device is under trial to enable reconnoitering and recording observations to be carried out by the pilot of an aëroplane, without the necessity of carrying a passenger. As the pilot has both hands occupied he cannot take notes, but he can speak into the mouthpiece of a dictagraph, a commercial recording phonograph, which records the words on a disk or cylinder. It is reported that an attempt was made to mount the instrument on the steering wheel, but the vibration gave trouble, so a special machine was provided to be strapped to the pilot's back.

*Public Service Commission of New York, First District, 154 Nassau St., New York City.

A Novel Method of Removing an Old Bridge

Removing an old girder bridge by cutting off successive panels from one end, and lifting them away by a derrick car standing on the remaining portion (this acting as a cantilever of decreasing length), is an unusual method of procedure carried out on the Northern Ry. of France, and described in the March number of the "Révue Générale des Chemins de Fer" (Paris) by Mr. Bouchard, Engineer of Maintenance-of-Way of the Northern Ry.

The bridge in question is across the Oise River, on the line between Paris and Creil. It has three double-track spans of about 93 ft., but the superstructure to be removed was built with continuous girders 280 ft. long, resting on the abutments and three piers. Falsework for the removal could not be used under two of the spans, as the river had to be left open for navigation. Traffic was diverted to one track, and along the stretch of abandoned track was established a plant for stacking and loading the old ironwork and another plant (on the opposite side of the river) for erecting the new structure in position for moving longitudinally into position. The cross-tie girders between the girders of the two tracks were cut, to avoid putting any torsional strains upon the structure.



METHOD OF REMOVING THE OLD SPANS OF THE BRIDGE OVER THE OISE RIVER; NORTHERN RY. OF FRANCE

Beginning at one end, as shown in the accompanying cut, panel lengths of about 19.7 ft. were detached and raised by a hand-operated derrick car, which then carried the detached panel to the loading yard on the bank. The heaviest load on the cantilever portion was in cutitng and raising panel No. 1 on the first span and panel No. 5, on the second span, the cantilever lengths being then 74.5 and 82.6 ft. respectively. For removing the third span, falsework was erected on piles driven in the bed of the river.

The superstructure being removed, the masonry piers were altered as required for the new structure, which is a continuous parallel-chord deck lattice-truss bridge. This was moved longitudinally into position, the bottom chord being lengthened temporarily so as to take a bearing on the timber bents and blocking on the piers, and so reduce the cantilever length of the structure while being launched. When this new structure was in position, it was gradually lowered to position on the piers. Track was then laid and traffic diverted to the new structure, so that the same operations could be repeated for the other track.

For cutting loose the panel lengths, experiments were made with cutting out the rivets and cutting the metal with chisels. This proved to be much too slow, and all the work was done by cutting the metal with oxyacetylene torches. The entire work on each track occupied about three months, and between the two periods a week was occupied in changing the single running track from the old to the new structure. Work was commenced about the end of December, 1911, and completed in July, 1912, double-track traffic being resumed in August. The cost was about $70,000, distributed as follows: grading to improve profile, $1000; track and ballasting, $3200; temporary switches and signals and their operation, $2400; masonry, $8000; steel superstructure, $56,000.

Fieldwork and Computations for Laying Out Subdivisions on Curved Street Lines

BY J. H. ANDERSON*

The first step necessary to properly subdivide a tract of rough ground into building lots is to prepare an accurate topographic map showing 5-ft. contours, on a scale of not less than 100 ft. = 1 in., and preferably 50 ft. = 1 in. Upon this map the proposed street and subdivision lines are first sketched, and then accurately located.

Before the subdivision lines can be calculated it is necessary that a closed traverse be run around the tract to be subdivided. All distances and angles of the traverse and the closure of the traverse are checked by computation.

It was found in making a traverse of the particular tract to be described that the angular error was 30", while the error in distance was about 1 in 3300. The ground was very broken and there was considerable underbrush, and on many of the hillsides it was necessary to "break chain" six or seven times, so that the error mentioned was considered allowable under the conditions.

After the exterior traverse was finally closed and had been accurately laid out on the map, the work was ready for computation. In this particular case the south line of the tract was also the quarter-section line running east and west, and a line perpendicular to this line was taken as the meridian to which all of the computed courses were referred. The intersection of the quarter-section line and this meridian was the origin of the coördinates.

It is not possible in the scope of this article to describe all of the steps necessary in computing and laying out the work, but a few examples will be given which will serve to illustrate most of the problems arising in such work.

The map should be very carefully drawn so that it can be used to check computations by scaling. To facilitate this work, light red lines may be drawn on the paper in North and South, and East and West directions. All such lines will have known latitudes and departures, and being drawn parallel to the axes they will be found very convenient in scaling the check distances. It is also important to use the best grade of detail paper so as to avoid shrinkage as far as possible.

FIELDWORK—From the office computation the notes

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are furnished for laying out the work in the field. The most satisfactory way of furnishing these notes for the use of the field parties is to trace the layout on conveniently sized sheets, referring such sheets if necessary to the general map of the tract drawn on a smaller scale. On these tracings are shown the degree, central angle, chord and arc lengths of each lot front, and the deflections for each lot corner on the curved lines.

In order to check the progress of the work and to know each night the extent of the completed work, the chief of the field party marked in red upon the blueprint map of the subdivision each lot corner staked, so that it was possible to tell by a glance at the map just how much of the work had been completed.

In laying out work of this character, it is not possible to run in the curves by the ordinary methods used

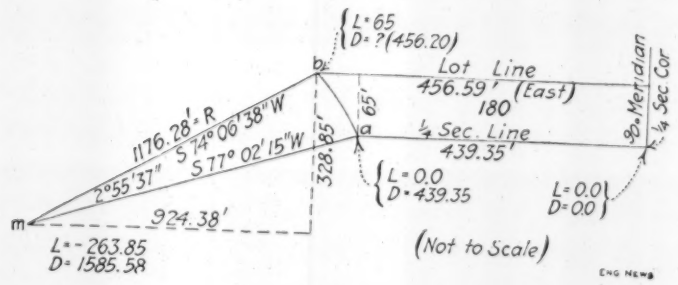


FIG. 1.

in railway work; viz., defining the degree of curve as the angle subtended at the center by a 100-ft. chord. Chords should be computed so that the distance shown is the exact distance along the curve. In other words, the degree of curve should be defined as the angle subtended at the center by a 100-ft. arc.

It is desirable to mark the corners of lots in a more permanent manner than by ordinary wood stakes, and it will be found much easier to drive iron rods or pipes into hard or frozen ground than to set wooden stakes. An iron bar, while it makes a very substantial monument is difficult to center, and it was found preferable to use short lengths of gas pipe about 1 in. in diameter. In set-

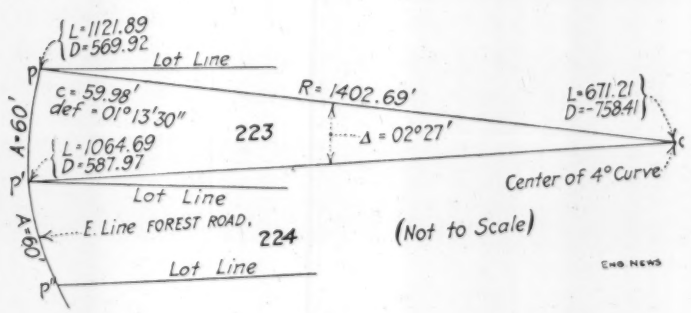


FIG. 3.

ting these pipes they were driven flush with the ground, and before the final center was taken a small wooden plug was inserted, in which a tack was set to mark the line. This method was found rapid and satisfactory.

The work described covered a tract of about 70 acres, and was laid out under the direction of Wm. H. Kimball, M. Am. Soc. C. E. The writer was in charge of the office work and computation, and the fieldwork was done under the direction of R. P. Hayes as chief of party. The entire work was completed in less than six weeks.

COMPUTATIONS—As before mentioned, the quarter-section corner was taken as the origin of latitudes and departures (see Fig. 1). The quarter-section line forms the south line of lot 180 as shown. The distance from quarter-section corner along the south line of lot 180 to the east line of Forest Road is 439.35 ft., which gives to the first lot corner on this street coördinates of $L = 0.0$, $D = 439.35$.

The tangent to the center line of the road at this point makes an angle of 76° 41′ 33″ with the quarter-section line, thus giving it a bearing of N 13° 18′ 27″ W. The radius to east line of the road at this point has then a bearing of S 77° 2′ 15″ W; and since its length is 1176.28 ft., the coördinates of the center of the curve are, $L = -263.85$, $D = 1385.58$.

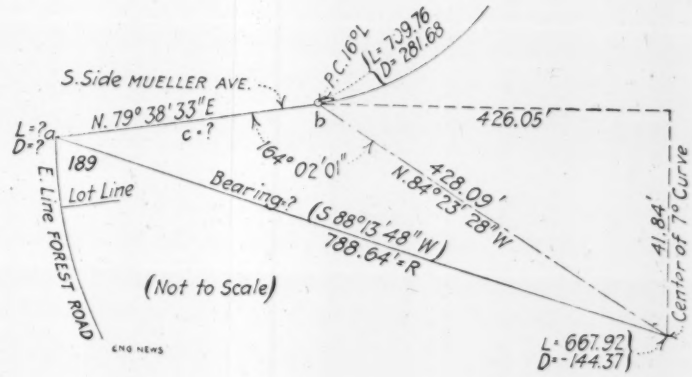


FIG. 2.

The lots adjacent to the quarter-section line were laid out with sides parallel to this line and with a width of 65 ft. along the meridian. To calculate L and D for lot corner b (Fig. 1) we proceed as follows: Since the lot is 65 ft. along the meridian, the L of b is 65 ft. The difference in L between b and m is 328.85 ft., which gives one side of a right triangle. The length of the radius to b, which forms the hypotenuse of the triangle, is 1176.28 ft. Solving for mn gives 929.38 ft.: 1385.58 — 929.38 = 456.20 ft., the D of corner b.

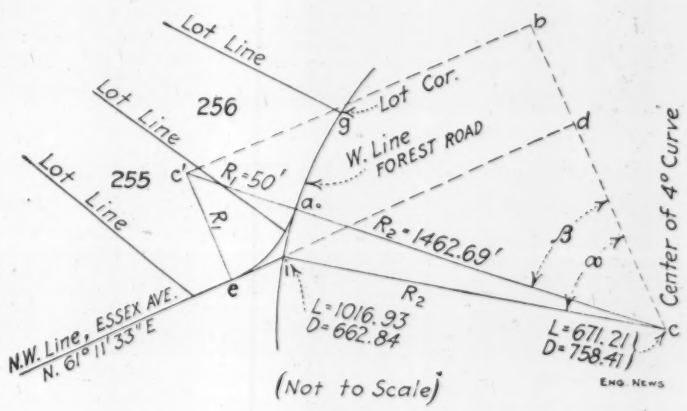


FIG. 4.

The bearing of the radius to b is found to be S 74° 6′ 38″ W, thus giving a central angle of 2° 55′ 37″. One-half of this central angle gives the deflection angle to be turned from the tangent at a to locate b.

The arc ab can be calculated from $A = R \frac{J}{57.296}$, where A = arc, R = radius, and J = the central angle. The chord ab can be calculated from $C = 2R \sin \frac{1}{2} J$, or from $C = \sqrt{(D_2 - D_1)^2 + (L_2 - L_1)^2}$, where D_2 L_2 and D_1 L_1 are the latitudes and departures of b and a respectively.

In like manner L and D can be calculated for any of the remaining lot corners of this group by adding 65 ft. to the L of the corner next below. Knowing the L and D of the front and rear corners, the length and bearing (in this case due east) of the line joining them can be calculated.

Fig. 2 shows the problem of calculating L and D for the intersection of the south line of Mueller Ave. with the east line of Forest Road. Forest Road at this point

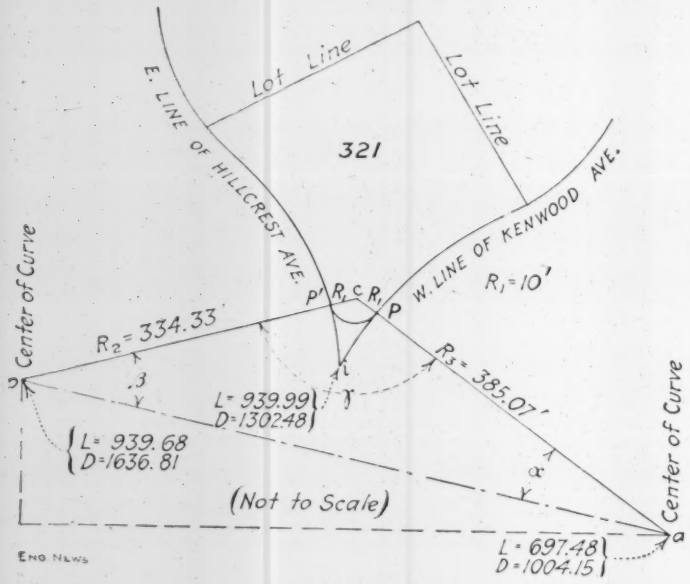


Fig. 5.

runs on a 7° curve, the coördinates of the center of which are as shown in Fig. 2. The south line of Mueller Ave. bears S 79° 38′ 33″ W an unknown distance from the P. C., whose coördinates are, $L = 709.76$, $D = 281.68$.

The radius to the curve on Forest Road intersecting the south line of Mueller Ave. has a length of 788.64 ft. and runs at an unknown bearing from the center of the curve whose coördinates are, $L = 667.92$, $D = -144.37$.

Knowing the L and D of points b and c, the bearing and length of the line joining them can be calculated. Knowing the bearing of ab and bc, the angle between them (164° 2′ 1″) is known (see Fig. 2). Three parts of the oblique triangle abc are now known, hence the bearing of ac and the length of ab can be computed. Knowing the bearing of ac the coördinates of a become, $L = 643.33$, $D = 643.89$.

In like manner the length, and the L and D of the end of any line having a known bearing and running from a point of known L and D can be calculated.

This corner was, of course, rounded off afterward by a curve but the L and D of the intersection was useful in checking the total arc along the street.

Fig. 3 illustrates the method of computing the L and D of the corners of lots to which definite arc frontages have been assigned. Corner p of lot 223 is one whose coördinates are known. Forest Road at this point runs on a 4° curve, the coördinates of the center of which are as shown in Fig. 3.

Knowing the coördinates of c and p, the bearing of the radius joining them is known. Since the arc was assumed to be 60 ft., by means of $\Delta = R \frac{J}{57.296}$, we solve for J. Knowing J, the angle between cp, the bearing of which is known, and cp' we can readily obtain the L and D of p'; in like manner the L and D of p'' can be obtained after assigning an arc frontage to lot 224.

The L and D of the rear corners of these lots, which lie on a straight line, are easily calculated, and hence the length and bearings of the lines connecting them.

For the case where both ends of a lot terminate in a curved street, proceed as above by assigning arc frontages along each street and calculating the L and D for each corner. The frontages assigned to each street must, of course, be such as will fit the topography and give an economical layout.

The intersections of street lines are, of course, rounded off by means of a curve. The intersection of the northwest side of Essex Ave. with Forest Road was rounded off by means of a curve of 50-ft. radius. To calculate the length of this connecting curve and the L and D of its ends, proceed as follows:

From Fig. 4 it is apparent that $cd = cb - db$ or $R_2 \cos \alpha = (R_2 + R_1) \cos \beta - R_1$. Solving for $\cos \beta$ we get, $\cos \beta = \dfrac{R_2 \cos \alpha + R_1}{R_2 + R_1}$.

The L and D of c are known as are also the L and D of i. The calculation of the L and D of i was previously described in connection with Mueller Ave. Knowing the coördinates of both ends of ci we can determine its bearing. Since the bearing of cd is known, the bearing of cd is readily determined therefrom.

Knowing the bearing of cd and ci, the angle α is determined; whence, substituting in the above formula, we determine $\cos \beta$ and β. Knowing β gives the bearing of cc'. The L and D for points a, c' and e can now be calculated. The arc $ae = R_1 \frac{\beta}{57.296}$. The arc ai can likewise be calculated; $gi - ai = ga$; g is a lot corner previously computed.

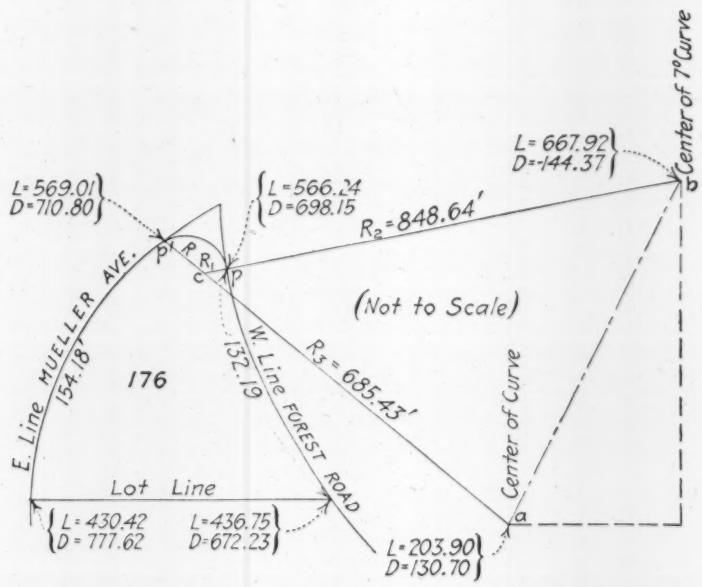


Fig. 6.

The intersection of Hillcrest and Kenwood Ave.'s was to be rounded off by means of a curve 10 ft. in radius: required the L and D of the center and of the P. R. C.'s and the arc length (Fig. 5).

The coördinates of a and b are known; therefore the length and bearing of ab can be determined; $bc = 334.33 + 10 = 344.33$; $ac = 395.07$;

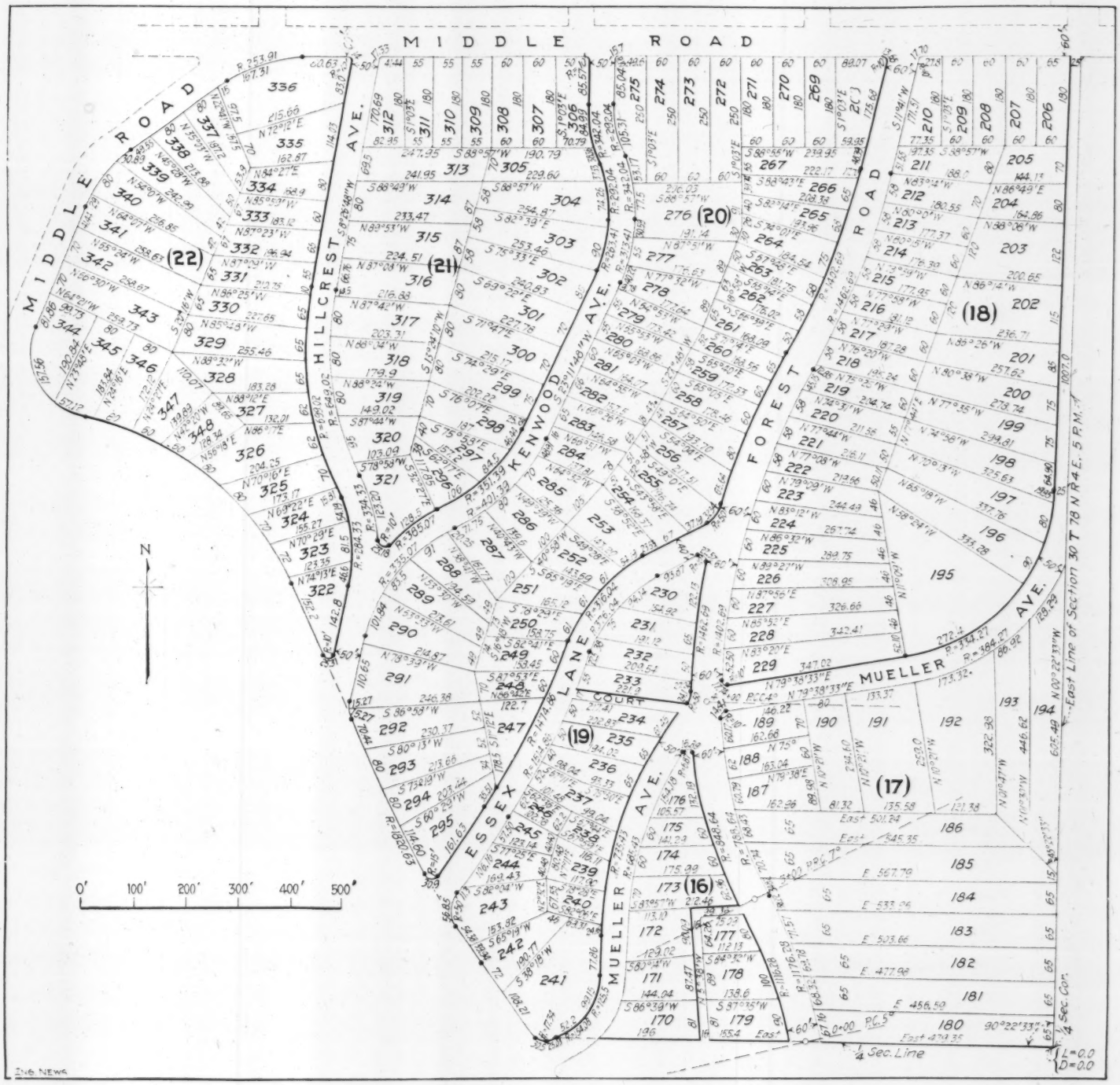


FIG. 7. SUBDIVISION OF A 70-ACRE TRACT IN BUILDING LOTS

$$Cos\ \tfrac{1}{2}\ a = \sqrt{\frac{S\,[S - (R_2 + R_1)]}{(R_3 + R_1)\ ab}}$$

where S equals $\frac{1}{2}\ |(R_1 + R_2) + (R_1 + R_3) + ab|$. Knowing a the bearing of R_3 is determined from the bearing of ab, and consequently the L and D for p and c;

$$\frac{R_2 + R_1}{sin\ a} = \frac{R_3 + R_1}{sin\ \beta}$$

whence

$$Sin\ \beta = \frac{R_3 + R_1}{R_2 + R_1}\ sin\ a$$

The bearing of bc is now known and L and D for p' are readily determined. Knowing a and β, we find γ by $\gamma = 180° - (a + \beta)$. Arc pp' equals $R_1 \frac{\gamma}{57.296}$. The lengths pi and $p'i$ can likewise be calculated, if desired.

At the intersection of the east line of Mueller Ave. west of Forest Road with the west line of Forest Road, a joining curve of 10-ft. radius was first used. This gave lengths of 144.18 ft. and 122.19 ft. to the west and east lines of lot 176 respectively. Later on it was decided to increase these lengths by 10 ft. each, making them 154.18 ft. and 132.19 ft. as shown on the map. The problem was to calculate the new radius of the joining curve. The procedure was as follows (see Fig. 6):

The coördinates of a and b were known, therefore the length and bearing of ab was determined. The L's and D's of p and p' were determined from the fact that the corners were at a fixed arc distance from the south line of lot 176, and the bearings of ac and bc were known: $\overline{ac}^2 = (R_1 + R_2)^2 + \overline{ab}^2 - 2\ (R_1 + R_2)\ ab\ cos\ \beta$. Solving for ac we get 678.56 ft.; $R_1 = 685.13 - 678.56$ ft. $= 6.87$ ft., which is the required radius.

The Computation of Simple Turnouts

By Anders Bull*

The generally adopted formula for computing the radius of a turnout from a circular curve (see Searles, pp. 161-164) being rather unwieldy, a simpler expression may perhaps be of interest.

The following symbols will be used:

R = radius of main curve;
r = radius of turnout;
g = gage of track;
L = angle of lead;
F = angle of frog;
n = number of frog.

In Fig. 1, showing a diagram for an inside and an outside turnout, radii are drawn from the centers of curvature of the turnout and main track to the frog

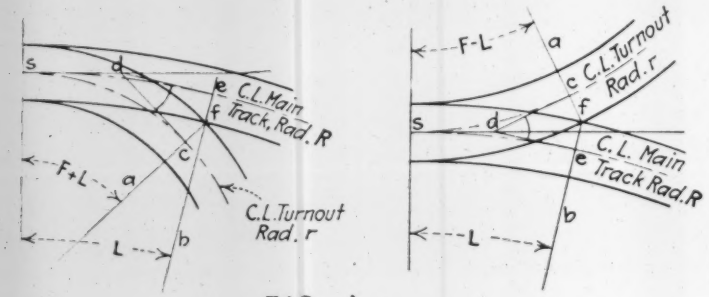


FIG. 1

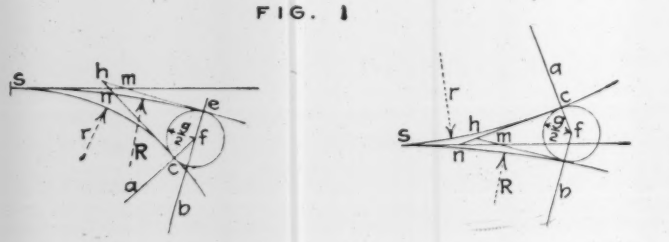


FIG. 2

point. Tangents drawn to the center lines of track opposite the frog point will then intersect the common center-line-tangent in one and the same point d. If this were not true, i.e., if they cut it in two points n and m (Fig. 2), we would have:

$$\overline{sm} = \overline{cm} \text{ as tangents to circle of radius } R \quad (1)$$

$$\overline{sn} = \overline{cn} \text{ as tangents to circle of radius } r \quad (2)$$

$$\overline{cm} + \overline{mh} = \overline{cn} \pm \overline{nh} \text{ as tangents to circle of radius } \frac{g}{2} \quad (3)$$

the upper sign referring to the left-hand diagram. Substituting (1) and (2) in (3) gives:

$$\overline{sm} + \overline{mh} = \overline{sn} \pm \overline{nh}$$

which cannot be true unless

$$\overline{mh} = \pm \overline{nh} = 0$$

From Fig. 1 it will then be evident that:

$$\overline{sd} = \overline{ed} = \overline{cd} = \frac{g}{2} \cot \frac{F}{2} = gn \quad (4)$$

$$\tan \frac{L}{2} = \frac{\overline{cd}}{R} = \frac{gn}{R} \quad (5)$$

$$\tan \frac{F \pm L}{2} = \frac{\overline{cd}}{r} = \frac{gn}{r} \quad (6)$$

which latter equation gives:

$$r = \frac{gn}{\tan \frac{F \pm L}{2}} = \frac{gn\left(1 \mp \tan \frac{F}{2} \tan \frac{L}{2}\right)}{\tan \frac{F}{2} \pm \tan \frac{L}{2}} \quad (7)$$

By substituting the values of $\tan \frac{F}{2}$ and $\tan \frac{L}{2}$ obtained from (4) and (5) in (7), and reducing, we finally have the simple algebraic relation:

$$r = \frac{gn^2 (2R \mp g)}{R \pm 2gn^2}$$

the upper signs referring to inside, the lower signs to outside turnouts.

Although the above expression may be used without aid of tables, it will prove convenient to tabulate values of $2gn^2$ and $\log gn^2$ for the various frog numbers. The expression is then brought into a logarithmic shape by two simple summations.

RADIUS OF TURNOUT FROM CURVE: TABLE FOR $2gn^2$ AND $\log gn^2$

(For Standard gage, 4 ft. 8½ in.)

Frog No.	$2gn^2$	$\log gn^2$	Frog No.	$2gn^2$	$\log gn^2$
4	150.667	1.8769872	8½	680.354	2.5317051
4½	190.687	1.9792922	9	762.750	2.5813522
5	235.417	2.0708072	9½	849.854	2.6283144
5½	284.854	2.1535926	10	941.667	2.6728672
6	339.000	2.2291697	10½	1038.188	2.7152458
6½	397.854	2.2986939	11	1139.417	2.7556526
7	461.417	2.3630633	11½	1245.354	2.7942629
7½	529.687	2.4229897	12	1356.000	2.8312297
8	602.667	2.4790472			

A Dredge-Cutter Recording Device

An ingenious device designed to indicate and record the movements of the cutter-head of a hydraulic dredge has been invented by Uldric Thompson, a member of the senior class of Cornell University, and H. S. Taft. The device, which they call the "standard dredge director," is described in the March issue of the *Sibley Journal of Engineering*, from which we have made a brief abstract.

The purpose of the device is to show on a diagram representing a cross-section of the canal prism, placed in front of the dredge operator, the location of the cutter-head, and also to make a chart, automatically, of the excavation done on the cross-section.

The apparatus consists of a device for combining the horizontal and vertical motions of the cutter-head so as to show its resultant movement reproduced on a horizontal plane. This is done by applying the horizontal

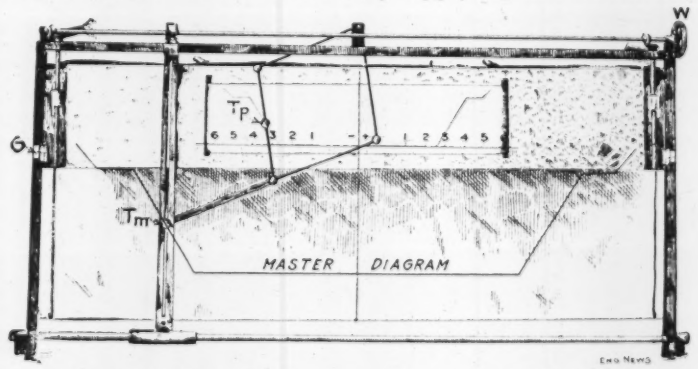


FIG. 1. DREDGE-CUTTER RECORDING DEVICE

component to a sliding guide, and the vertical component to a pointer T_m (see Fig. 1). The vertical movement of the pointer is actuated by running a wire from a point on the cutter-arm around a differential pulley mounted on the projecting A-frame, the other end of the wire

*Designer, Public Service Commission, 154 Nassau St., New York City.

being attached to a weight. Another wire, similarly weighted, is wound around the smaller circumference of the differential pulley and is then run back and connected to the director. In this way all vertical movements of the cutter-arm are reduced and transferred to the pointer.

The horizontal component of the cutter movement is reproduced as follows: A metal quadrant is pivoted at its center, on a vertical axis located midway between the spuds, on the rear deck, or on the ceiling of the boiler-room. Wires are fastened from the ends of the arc and then run around the arc to pulleys on the opposite side and thence forward to the director (see Fig. 2).

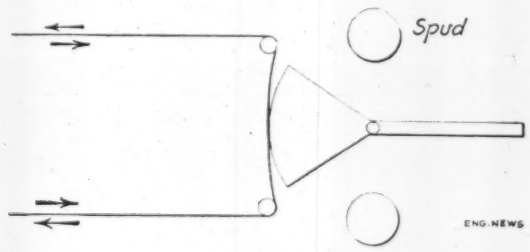


FIG. 2. DIAGRAM SHOWING DEVICE FOR TRANSFERRING CUTTER-HEAD MOVEMENT TO RECORDING DEVICE

The center line of the quadrant is then lined up with the center line of the river or canal. This may be done by sighting along the line to some distant point in the canal center line. During operation the quadrant may be kept in line either by hand or by a gyroscope mounted on the quadrant. In either case the quadrant will remain stationary as the boat swings. Hence, as the relative positions of the boat and quadrant change, the wires will be pulled through distances proportional to the swinging of the dredge. By selecting the proper radius for the quadrant, the horizontal component is reduced to the same scale as the vertical component.

A proposed improvement is to locate the quadrant and gyroscope in the wheel house and thus make the apparatus more compact. The gyroscope would keep the center line of the quadrant always parallel to the center line of the canal or river prism. Hence, the relative movements of the boat and quadrant would be the same as with the quadrant placed between the spuds. This arrangement could not be used if the centering were done by hand. In case the canal is curved, the apparatus must be recentered at short intervals.

A pantagraph mechanism is used to trace the path of the cutter; a pointer for the "master-diagram" and a stylus for recording diagram. T_m is the master tracer or pointer and T_p the stylus on the recorder. (See Fig. 1.) As may be seen from the illustration, the pointer moves behind a plate of glass upon which has been drawn a master-diagram of the section to be cut out.

It is the duty of the dredge operator first, to dredge to the cross-section roughly and then to finish off the edges by manipulating the cutter so that the pointer follows the line of the master-diagram.

Change of water level may be allowed for by raising or lowering the glass plate by turning the wheel W; G shows a gage for this regulation.

The director is equipped with a mechanism for automatically making charts of the work done by the dredge. A new section of a continuous chart is rolled into place every time the spuds are shifted. This is accomplished by means of simple electrical connections. In this way a chart of the cross-section dredged is made for each new position of the dredge.

The blank charts may have a master-diagram drawn on them so that an easy comparison may be made between the actual cut and the cross-section called for. The recording mechanism is locked and sealed, and the chart thus gives the government or canal company an absolute check on the work done by the contractor.

NOTES

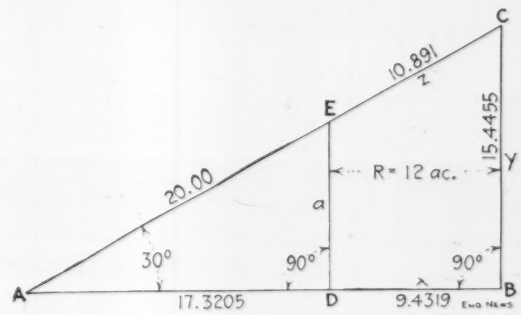
A River Survey made on the Ice was described by A. L. Webster, County Surveyor, Wheaton, Ill., in a paper presented at the annual meeting of the Illinois Society of Engineers and Surveyors at Chicago, Jan. 22-24. The survey was for a drainage district on the DuPage River, which stream is mainly a series of sloughs in its upper reaches. It was found to be almost impossible to make complete surveys to determine the proper location of the proposed channel, and necessary profiles, etc., on account of the swampy conditions existing. Therefore the plan was adopted of running the lines in winter, taking soundings for profiles and making careful and complete references of all points. All tangent lines were run to an intersection, and all points of intersection and points of curve, etc., were carefully referenced to permanent marks along the shore. Occasional measurements were made along property lines from the proposed line to stakes or other marks, and such measurements taken as will be useful in plotting the wet lands for the purpose of assessing their owners. The center thread of the river was frequently the dividing line of ownerships, and it was often difficult to determine it, although important, owing to high values of land. Besides these references, holes were chopped in the ice and long stakes driven which will help later in picking up the lines quickly, as well as to define clearly the proposed route. These will be safe, as the ice goes out slowly.

This work was done in this manner in a third of the time required if done at any other time of the year, and the results were far more satisfactory. The work had its difficulties and trials. Once when the thermometer registered below zero, the party was working next to the tracks of the Chicago Great Western R.R. when a train passed, and at the psychological moment a flunky in the dining car saw fit to empty a pan of dish water out of the window, drenching one of the boys thoroughly. Another day the transit-man broke through an air hole into the water up to his arm pits, smashing the transit. This happened when the ice was 18 in. thick on the average, but the river is fed largely by springs and great care had to be used, especially when snow covered the ice.

⁂

Lots Between Non-Parallel Lines—A correspondent in Australia, A. G. Little, writes as follows: In your issue of Jan. 23, 1913, p. 173, appears an interesting problem under the heading above. I think the method of solving the problem adopted by Mr. Dinsmore a rather laborious one and suggest the following simple formula:

Referring to the accompanying figure; given, say a = 10 ch. A = 30°. R = 12 acres = 120 sq.ch.



$$y = \sqrt{a^2 + 2\,R \tan 30^\circ} = 15.4455 \text{ ch.}$$

$$a = \sqrt{y^2 - 2\,R \tan 30^\circ} = 10.0000 \text{ ch.}$$

$$x = \frac{120}{\frac{1}{2}(a + y)} = 9.4319 \text{ ch.}$$

$$z = x \sec 30^\circ = 10.8910 \text{ ch.}$$

Compressed-Air Apparatus for Dislodging Anchor Ice—An apparatus for utilizing compressed air to dislodge the anchor ice which forms in the ports of the water-works intake cribs during the winter was installed at the Two Mile crib of the Chicago, Ill., water-works during the fall of 1911. It is arranged as follows: A new 10x8x10-in. Westinghouse air compressor was installed and arranged to discharge into a receiving tank of about 50 cu.ft. capacity. The operation of the compressor is arranged to give a maximum of about 80 lb. pressure in the receiving tank. When any of the ports show signs of being blocked by anchor ice a standpipe running down into the center of the port is connected with the air-receiving tank by means of a 2½-in. hose. After the hose and standpipe are in place the full load of air under 80 lb. pressure is discharged through the hose and into the port by operating a quick-opening valve at the air tank. By giving the full head of air through the port and from expansion of the air in the water the force to dislodge the ice which has formed on the walls of the port is secured. In former years the anchor ice was dislodged by using water under pressure in practically the same manner as described above. It was found, however, that the water would not give the same result as a like quantity of air under the same pressure, and after making tests of the use of water as compared with air the change was made to the air apparatus. [From a recent report of the Department of Public Wroks, Chicago, Ill.]

A Sunny Hour Chart is a simple device for determining in which window of a building the sun will shine at any season of the year, and how long it will shine (provided, of course, it is on a cloudless day). The chart consists merely of a circular diagram with a circumference graduated into 24 parts, numbered from 1 p.m. to 12 p.m., and 1 a.m. to 12 a,m,, and having radial lines drawn from the center of the circle to the times of sunset and sunrise for the different months of the year. Through the diameter of the circle, 12 a.m.—12 p.m., is a meridian.

The plan of the building used must also have a meridian drawn upon it in its correct relative position. The chart is placed on the plan of the building with the two meridians parallel. To find at what time of day the sun begins or ceases shining through any window, a straight-edge is laid on the chart in such a way that it passes through the center of the circle and is parallel to the wall in which the particular window is built. The sun will begin or end shining through the window at the hour indicated where straight-edge intersects the circle. If the wall runs westerly of the south, the sun will begin to shine in at the hour indicated, and if the wall runs easterly of the south the sun will cease to shine in at the hour indicated.

In case it is desired to apply the chart to an existing building in order to determine in what rooms the sun will shine at any hour of the day, the chart is laid upon a table and properly oriented by means of a pocket compass. If no compass is available the chart may be oriented by turning it so that the point on its circumference which corresponds with the time of day as read from a watch is in line between the sun and the center of the circle.

The standard chart is approximately correct for all latitudes between 35° and 45° and special charts may be obtained for higher or lower latitudes. The "sunny hour chart" is copyrighted and published by Williams, Brown & Earle, Inc., Philadelphia, Penn. Printed on tracing cloth it sells for 50c., and on celluloid for $1.

Diamond Drilling to investigate the rock conditions for a dam and outlet tunnel on the Little River in Alabama, is described in "Mine and Quarry" (Sullivan Machinery Co.) by A. B. Cudebec,* who was resident engineer for the Little River Power Co. The dam will be about 2900 ft. long, with a spillway of 350 ft. The tunnel will be a mile in length, leading to the pressure pipes, which give a working head of 537 ft. The contract for the core-drilling was given to the Sullivan company and five machines were used: two with screw feed and friction escapement, of 500 ft. capacity; two hydraulic-feed drills of 1500 ft. capacity, and one hydraulic-feed drill of 3000 ft. capacity. This last machine was equipped to take a 2-in. core, while the others used a 1⅛-in. bit. As the formation was firm it was decided later to use the smaller bit on all machines. The work is described by Mr. Cudebec as follows:

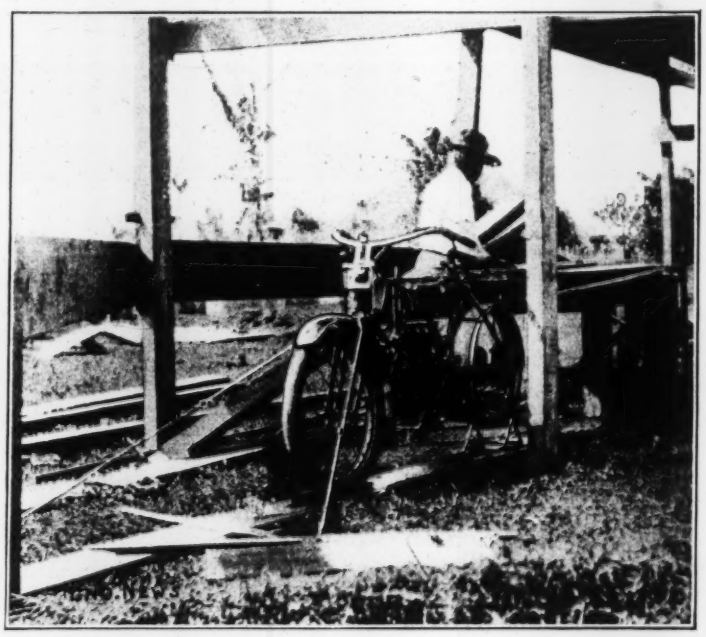
Three parallel lines of holes were drilled upon the dam site, at right angles to the stream. The holes were staggered to form diamond-shaped figures, approximately 100 ft. on a side. A line of holes was drilled along the tunnel line; also down the pipe line location, and at the power house, as well as along the extensive tail-race location. All the holes were carried down to a depth where 20 ft. of bed-rock core had been taken. In addition to this depth, the holes on the middle line at the dam site were carried to 100 ft., and two holes were sunk in the reservoir to the limestone foundation, a depth of 550 ft. A total of 74 holes were sunk, and 6400 ft. of drilling completed. The drilling proved that the proposed bed of the reservoir was watertight and safe for a dam foundation.

All holes were sunk in the dry except eight in the river bed, which were handled from timber cribs. The usual depth of water was about 6 ft. The ordinary practice was to sink standpiping through the overburden, gravel, etc., of the bank or river bottom, until rock was struck. The core fittings and diamond bit were then placed in position and drilling resumed for 20 ft., or until the core demonstrated that not a boulder, but solid rock (free from cavities) was being penetrated. The machines were operated day and night, and the job completed in 78 days, including Sundays. Several sudden floods delayed the worwk.

The cores from the holes bored along the line of the tunnel showed that the rock was a series of hard sandstone and conglomerate, laid down in water-tight layers, with the exception of one small vein of coal, which was not continuous. No timbering will be needed, and under a water pressure of 125 lb. no leakage was developed. It is proposed to line the tunnel with concrete about 18 in. thick.

*Engineering Department, Utah Power & Light Co., Salt Lake City, Utah.

An Improvised Sawmill Motor—A correspondent in the Philippine Islands sends us the acompanying photograph, which shows an F. & N. motorcycle belted to a circular saw in use on the construction of an Albay Province school



A Motorcycle-Operated Sawmill

house. B. F. Miils, a former District Engineer of the Bureau of Public Works of the Philippine Islands, is the contractor for the building and the originator of the scheme.

A Eulogy of the Land Surveyor—The vocation of the Civil Engineer has always been invested with a dignity of its own. But it seems to me that of late years, in paying him the honor which is his just due, we are apt to fix a little too wide a gap between him and his humbler brother, the Surveyor. We give engineering the chief attention in our technical schools, but surveying we are wont to relegate to the freshman class. Yet the profession of the surveyor deals with one of the oldest and most fundamental facts of human society—the possession and inheritance of land. Fire, flood and earthquake wipe out the greatest works of the engineer, but the land continueth forever.

Curiously enough the surveyor is isolated in his calling, and therein lie his responsibility and his temptations. The lawyer comes nearest to understanding the work, yet of the actual details of a survey most lawyers are woefully ignorant. The business man who can judge to a hair the fulfillment of a contract has no eye for the shortened line or the shifted landmark.

Dishonesty in ordinary business life cannot long be hid, and errors in accounts quickly come to light, but the false or faulty survey may pass unchallenged through years, for few but the surveyor himself are qualified to judge it. I maintain that in the hands of the surveyor, to an exceptional degree, lie the honor of the generations past and the welfare

of the generations to come; in his keeping is the Doomsday Book of his community, and who shall know if he is false to his trust? Therefore I believe that to every surveyor who values his honor and has a full sense of his duty the fear of error is a perpetual shadow that darkens the sunlight.

Yet it seems to me that to a man of active mind and high ideals the profession is singularly suited; for to the reasonable certainty of a modest income must be added the intellectual satisfaction of problems solved, a sense of knowledge and power, increasing with years, the respect of the community, the consciousness of responsibility met and work well done. It is a profession for men who believe that a man is measured by his work, and not by his purse; and to such I commend it. [From "Boundaries and Landmarks," by A. C. Mulford.]

Cost of Maintaining Horses—The following data are compiled from the annual report of the Public Works Department of the City of Boston, Mass., and refer to horses maintained by the highway division for street cleaning, watering and oiling service. This division of the Public Works Department has the care of 135.6 miles of paved streets and 114.4 miles of macadam road. The total area of streets cared for is 3,345,200 sq.yd. For this work the city expended a sum of $614,658 for the year ending Jan. 31, 1912.

The accompanying table is based on a year of 365 days and a total average number of horses kept of 154. The data are based on the expenses of six municipal stables located in South Boston, East Boston, Charlestown, Roxbury, South End and West End. The average number of horses per stable varied 12 to 58. The labor at the various stables was the most variable item, ranging from $165 per horse per year at Roxbury to $240 per horse per year in East Boston. About 1/11 of the total number of horses were driving horses for use of the officials of the bureau, and the remainder were cart horses.

COST OF MAINTAINING HORSES, BOSTON, MASS.

Items	Total Cost	Cost per Horse per Day	Cost per Horse per Year
Labor	$29,805	$0.529	$193
Hay and grain	29,391	0.523	190
Shoeing	6,567	0.117	42.50
Veterinary services and medicine	908	0.016	56.00
Stable rent, lighting, heating, repairs, etc.	12,039	0.214	77.75
	$78,710	$1.399	$508.25

The amount of feed consumed was as follows:

	Amount used Lb.	Price paid Highest	Price paid Lowest
		Per ton	
Hay	1,033,160	$24.50	$16.50
Straw	66,369	19	11
Shorts	23,900	29	26
		Per bushel	
Oats	24,451 bu.	$0.58	$0.39

In the sewer bureau of the same city the cost of maintaining 48 horses and the average cost per horse were as follows:

Items	Total Cost	Average Cost per Day	Average Cost per Year
Labor	$11,803.69	$0.67	$246
Hay and grain	7,744.07	0.44	161
Shoeing	1,806.50	0.10	37.50
Veterinary services, medicine and clipping	225.00	0.01	4.75
Stable goods	219.30	0.01	4.25
Totals	$21,798.56	$1.23	$453.50

A Convenient Rule for Pipe Sizes is given by L. B. Lent, as follows: The velocity of flow in water pipes is very commonly taken at 3 ft. per second. This does not produce excessive friction loss even in comparatively small pipes. With this velocity: Diameter of Pipe (in inches) is equal to the Square Root of the Quantity of Water flowing (in cubic feet per minute).

The rule is not exact, but involves an approximation of something less than 1%. The rule, of course, merely expresses the relation between area, velocity and volume of flow, and involves no hydraulic relations or laws.

The rule can be used with gallons per minute after dividing by 7.5 (more exactly 7.48) to get cubic feet per minute. It can be used with a velocity of flow other than 3 ft. per second by first solving the problem for the 3-ft. velocity, then dividing by the square root of the correct velocity and multiplying by the square root of 3.

A Dragline Excavator for Side Track Construction was very successfully employed on the Chicago, Milwaukee & St. Paul Ry., at Turkey River, Iowa. The track runs on a fill parallel to the Mississippi River and the dragline excavator worked along the bottom land between the river and the old embankment.

The side or passing track is 4000 ft. long, and the crown of the fill is 25 ft. wide, varying in height from 10 to 22 ft. The fill was all made from one cut. The excavation amounted to 40,000 cu.yd., consisting of mud, sand and gravel. The digging was made extremely hard by the severe weather, in fact the machine had to dig through a foot of frost. In order to get a hold with the bucket to move ahead, it was necessary to shoot holes in the frozen ground.

During the last ten days the work was further complicated by the fact that in order to borrow sufficient material for the 22-ft. fill, the machine had to dig below river level and freezing weather made this a very difficult job. The dragline excavator completed the work in spite of many difficulties in one month and ten days. [From the April issue of "The Excavating Engineer."]

Vitrified Paving Block Tests—The city of Albany, N. Y., has 37.6 miles of vitrified brick pavements; over 39% of all the pavement laid in 1912 was of this type. The following summary taken from a recent report of the Department of Public Works gives the results of different tests made during the year 1912:

Make of Brick	Absorption of water Per cent.	Modulus of rupture Lb. per sq.in.	Transverse strength lb.	Impact Test Loss in lb.	Impact Test Per cent.
Clearfield	2.11	2045	10,045	13.98	18.92
Watsontown	2.28	2031	11,935	15.00	19.36
Allegany Valley	1.77	2147	13,333	15.34	18.49
Allegany Valley	2.03	2204	12,468	12.81	15.69
Allegany Valley	2.05	2179	12,897	16.53	19.67
Bradford	1.24	2402	15,408	15.88	17.33
Watsontown	2.54	1909	11,175	15.60	19.80
Clearfield	3.03	2077	10,970	14.05	19.11
Corning	1.15	2390	13,185	12.28	16.87
Corning	0.93	2135	11,122	10.31	14.09
Bradford	1.00	2045	13,345	16.15	17.79
Corning	1.83	2192	12,925	12.38	16.40
Corning	1.29	2246	11,725	14.75	19.17
Allegany Valley	1.84	2038	12,150	15.31	18.54
Clearfield	1.57	2032	10,720	13.31	18.13
Bradford	1.47	2071	13,625	16.55	18.46
Allegany Valley	1.88	2521	14,010	13.04	15.92

Requirements of specifications for paving blocks:
Shall not sustain a loss of weight of more than 20% in the impact or abrasion test.
Shall not absorb more than 3% of their weight of water.
Modulus of rupture shall not be less than 2000 lb. per sq.in.

The Cost of Sewers Constructed by Contract in Chicago, Ill., during 1911, is given in the recent annual report of the Department of Public Works as follows:

PIPE SEWERS

Length in ft.	Internal diameter in ft.	Average cut in ft.	Amount	Cost per ft.
4,427	3/4	7.3	$4,830.46	$1.09
167,430	1	8.7	225,598.10	1.35
83,963	1 1/4	10.0	125,970.88	1.50
24,150	1 1/2 d. s.	11.0	47,343.11	1.97
4,056	1 1/2 d. s.	10.8	10,238.19	2.52
514	2 d. s.	13.2	1,799.10	3.50
284,540			$415,775.74	

BRICK SEWERS

8,618	2 s. r.	12.4	$24,784.40	$2.88
9,394	2 d. i.	12.8	30,158.29	3.22
1,200	2 d. r.	19.0	5,400.00	4.50
5,458	2 1/2 d. i.	13.6	24,617.75	4.51
4,847	2 1/2 d. r.	12.5	18,417.17	3.80
8,988	3 d. r.	12.7	44,897.80	5.00
5,282	3 1/2 d. r.	15.7	28,938.90	5.48
2,681	3 3/4 d. r.	15.0	14,745.50	5.50
2,651	4 1/2 d. r.	14.0	13,255.00	5.00
4,004	4 1/4 d. r.	14.5	20,020.00	5.00
2,663	5 1/2 d. r.	18.0	18,641.00	7.00
1,350	6 d. r.	19.0	12,150.00	9.00
351	6 1/4 3 r.	17.5	3,159.00	9.00
57,487			$259,184.81	

Initial Strains in Boilers—"When the Pennsylvania R.R. intended to change its specifications for boiler plate many years ago, it was the custom, as far back as 31 years ago, that from all worn-out boilers testpieces were taken and retested. Original duplicate testpieces from the new sheets were laid away, and when the worn-out firebox sheets were returned to the testing department the original duplicates were searched for and tested in comparison with the worn-out plate. This practice was carried on for 13 years, and these tests invariably have shown (1) That, as far as it can be traced, the effect of the heat on the boiler sheet reduced any internal stresses due to the rolling; and (2) that whatever defects are found could almost invariably be traced to mechanical defects in the shop, in bending in flanging, in riveting, in drifting the rivet holes cold, and these effects then made their appearance by and by through overstrain." (P. Kreuzpointner before Sixth Congress of International Association for Testing Materials, 1912.)

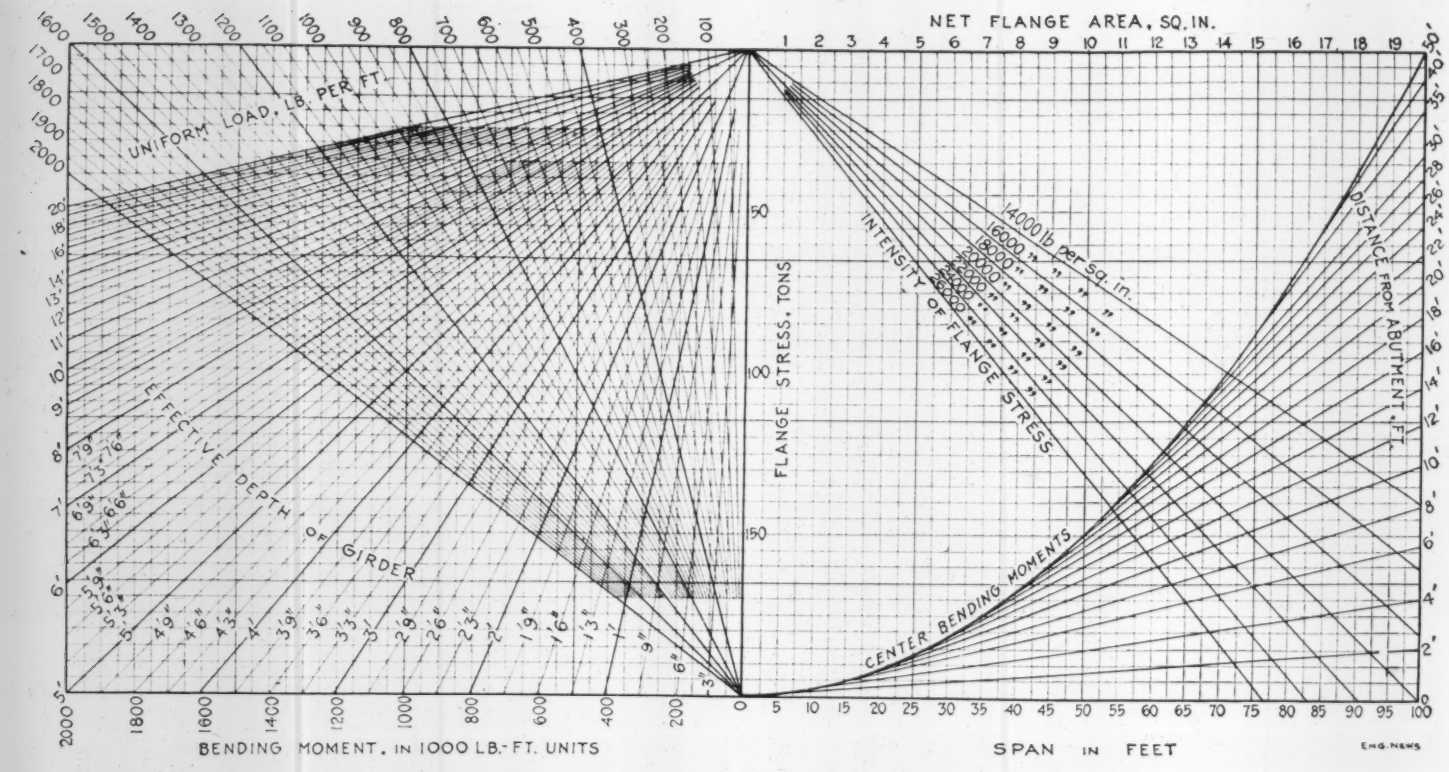

NET FLANGE AREA, SQ. IN.
UNIFORM LOAD, LB. PER FT.
EFFECTIVE DEPTH OF GIRDER
FLANGE STRESS, TONS
INTENSITY OF FLANGE STRESS
14000 lb. per sq. in.
16000 " " " "
18000 " " " "
20000 " " " "
22000 " " " "
24000 " " " "
26000 " " " "
CENTER BENDING MOMENTS
DISTANCE FROM ABUTMENT, FT.
BENDING MOMENT, IN 1000 LB.-FT. UNITS
SPAN IN FEET
ENG. NEWS

FIG. 1. DEAD-LOAD BENDING MOMENT DIAGRAM FOR PLATE-GIRDER DESIGN

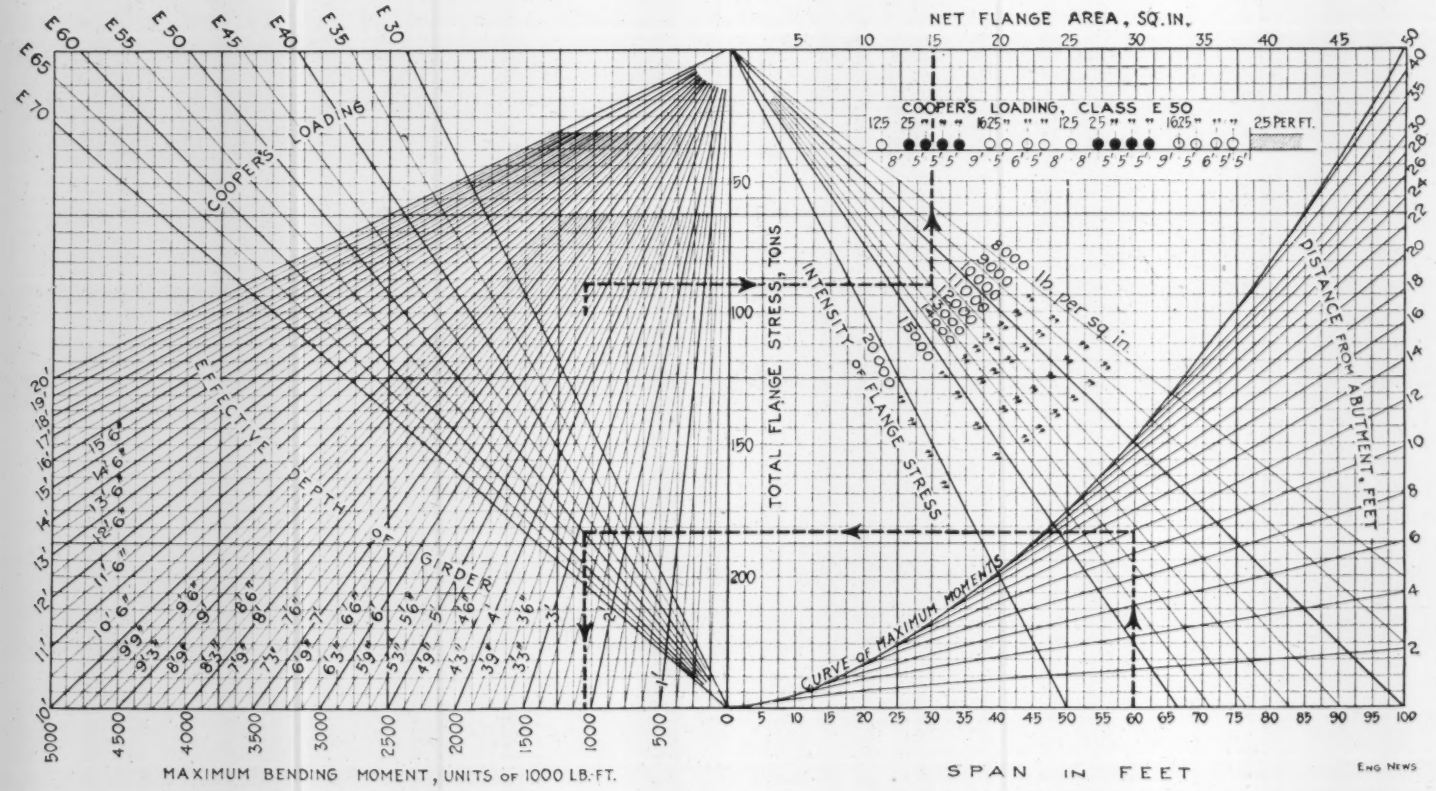

NET FLANGE AREA, SQ. IN.
COOPER'S LOADING, CLASS E 50
25 PER FT.
COOPER'S LOADING
E 30 E 35 E 40 E 45 E 50 E 55 E 60 E 65 E 70
EFFECTIVE DEPTH OF GIRDER
TOTAL FLANGE STRESS, TONS
INTENSITY OF FLANGE STRESS
8000 lb. per sq. in.
9000 " " " "
10000 " " " "
11000 " " " "
12000 " " " "
13000 " " " "
14000 " " " "
15000 " " " "
20000 " " " "
CURVE OF MAXIMUM MOMENTS
DISTANCE FROM ABUTMENT, FEET
MAXIMUM BENDING MOMENT, UNITS OF 1000 LB.-FT.
SPAN IN FEET
ENG. NEWS

FIG. 2. RAILWAY LIVE-LOAD BENDING MOMENT DIAGRAM, FOR PLATE-GIRDER DESIGN

[Cooper's E-30 to E-70 Loadings.]

To use Fig. 1 or Fig. 2. Find length of span (ft.) on right-hand bottom scale; thence follow vertically to the diagonal giving the distance out from the abutment to the point of girder in question (ft); thence follow horizontally to left, to the diagonal giving the intensity of loading. (In Fig. 1, lb. per lin.ft.; in Fig. 2, Cooper's class of engine and train loading); thence follow vertically downward to the bottom scale, and read bending moment (units of 1000 lb.-ft.); also follow vertically upward to diagonal giving effective depth of girder (ft. and in.); thence follow horizontally to right, and on middle vertical read flange stress (tons total); follow farther to right, to diagonal giving allowed unit-stress in flange (lb. per sq.in.); thence follow vertically to top scale, and read required flange area (sq.in.).

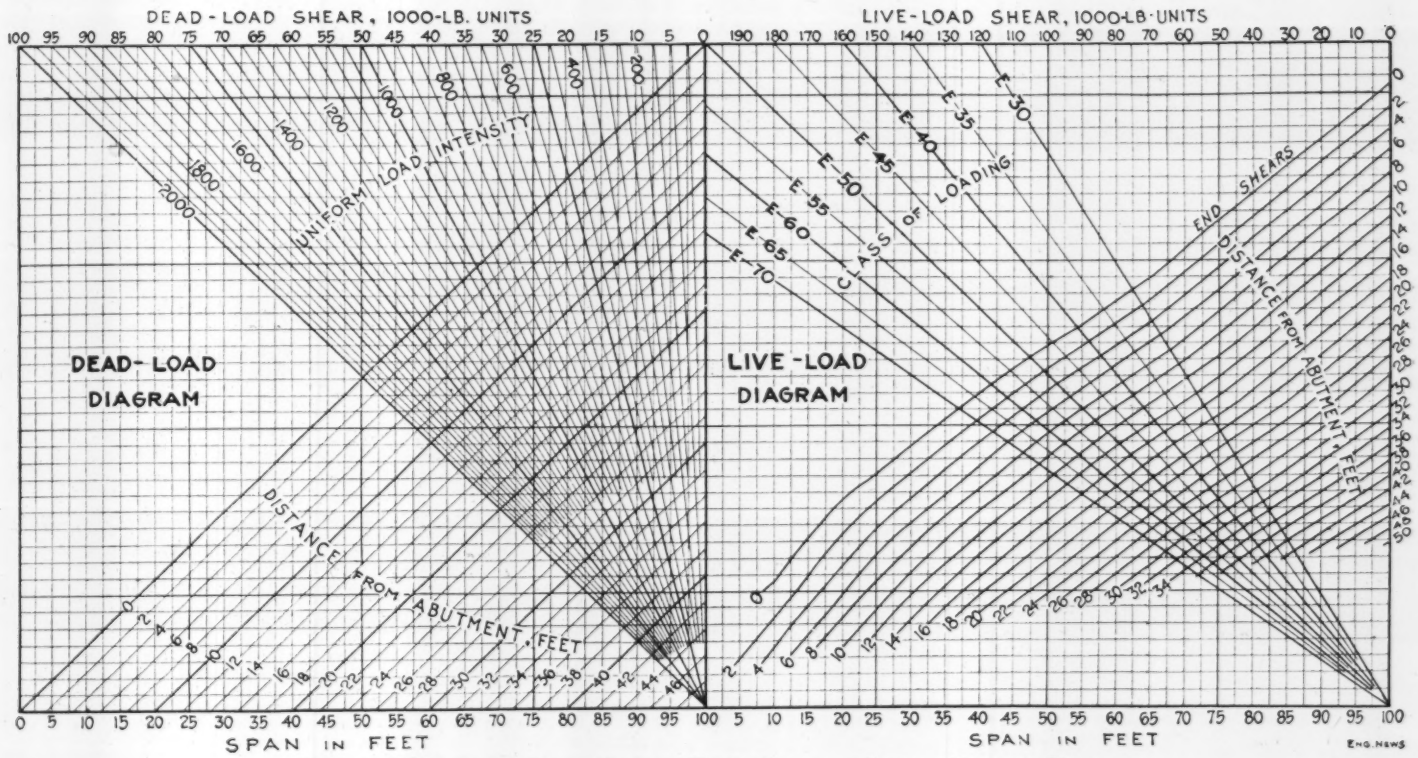


FIG. 3. DEAD AND LIVE SHEAR DIAGRAM FOR PLATE-GIRDER DESIGN

(Left half for dead-load shear; right half for live-load shear.)

Find length of span (ft.) on bottom scale; thence follow vertically to the diagonal giving the distance (ft.) from abutment to point considered; thence follow left or right horizontally to diagonal giving intensity of load (lb. per lin.ft. for diagram at left; Cooper's classes E-30 to E-70 for diagram at right); thence follow vertically to scale at top, and read shear (1000-lb. units) at point of girder considered.

Charts for Designing Plate-girders

BY GILBERT D. FISH*

The three diagrams herewith (two moment diagrams, one shear diagram) were designed as a means of finding the principal stresses in plate-girders due to dead-loads and moving loads, and the required flange areas at various sections. By use of these diagrams the bending moments and shears due to own weight and to superimposed uniform load are readily obtained for all varieties of simple beam, from the rolled I-beams of a floor to the plate-girders of a railroad bridge.

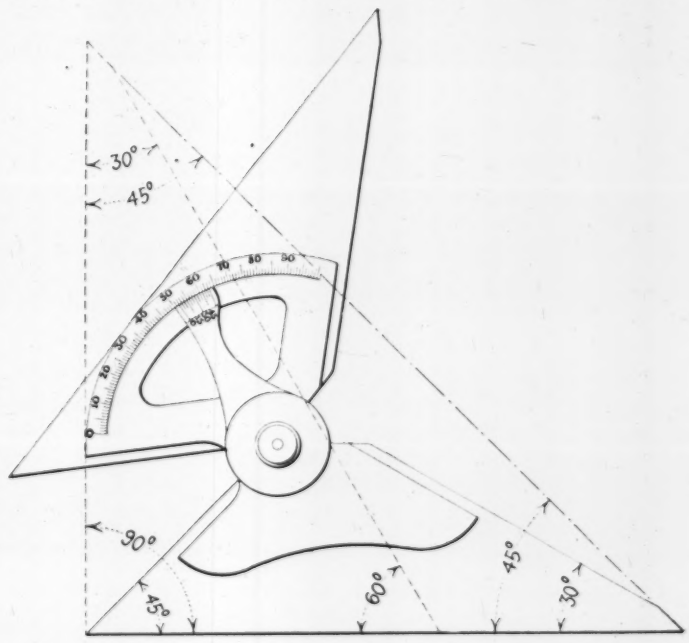
The train loadings given in Theodore Cooper's "Specifications for Steel Railroad Bridges and Viaducts" are the basis for the live-load stresses (Figs. 2 and 3).

The net flange area required at any section of the girder is the sum of the areas found separately for dead-loads and live-loads. Various assumptions may be made as to depth of girder and allowable intensity of stress in the flanges.

The complete design of a plate-girder is made easy by the use of these charts in connection with the cover-plate tables given in ENGINEERING NEWS of Jan. 25, 1912.

Combination Drafting Instrument

The accompanying illustration shows a combination protractor and triangles for the use of draftsmen. The protractor has an arc 4 in. in diameter, graduated to degrees and reading by a vernier to 5 min., though it is probable that the accurate setting of the instrument cannot be made to such minuteness. The clamping screw serves not only to hold the triangles in position but as a thumb-knob for handling the instrument. The instrument is claimed to be particularly convenient in setting off angles, dividing circles, drawing oblique parallel lines and perpendiculars to oblique parallel lines, transferring angles and for laying off angles on each side of a



COMBINATION DRAFTING INSTRUMENT INVENTED BY EDWIN Z. LESH

line without changing the setting. The protractor is steel and the triangles have transparent blades, the longest edge of which is 7 in.

The instrument was invented by Edwin Z. Lesh, and is manufactured by the "3-in-1" Manufacturing Co., Hartford, Conn. It sells for $1.50.

*Columbia University, New York.

A Guide for Close Estimating on Cost of Power Plants

Engineers are frequently called on to submit estimates of cost on construction of various works before accurate of sufficient information is at hand of details of anything but the principal apparatus involved. Sometimes this has to be done before drawings and specifications are available, and yet the estimates may cover the expenditure of large sums, so that the need of close approach to the actual expense is needed. F. W. Gay, chief mechanical engineer of J. G. White & Co., New York City, in an article in the "Journal of the Worcester Polytechnic Institute" March, 1913, shows a method of checking these estimates and confining the greatest chances of error to minor parts of the installation.

According to his scheme, the first work is in the determination of the relative importance of the various items to be covered by an estimate. From his experience, he has compiled data and prepared diagrams covering power plants from 2000 to 40,000 kw. in capacity.

The diagrams show that: *engines and foundations* constitute from 33.6% to 61% of the total equipment cost; an average of 50%. *Boilers, settings and foundations*, from 17.25% to 31.5%, average about 25%. *Piping, complete*, from 7% to 17%, averages about 11%. *Condensers, complete with foundations and auxiliaries*, 10% to 15%, average at 11%. *Circulating-water system*, 4.5% to 8%, averages 6.5%. Thus in these five groups is a minimum of 72.35% of all apparatus items, leaving the remainder, 27.65%, to be divided among at least eleven groups, including "miscellaneous." If, therefore, the greater part of the allowable time is spent on these five groups he believes that the result will justify the expenditure of time and money.

Boilers, foundations and settings can be estimated closely, as can also the condensing apparatus. Engines, foundations, piping and circulating-water systems present greater difficulties, relatively, about in the order named. He finds it possible to estimate as close as 3% on *boilers, installed; on engines, installed*, as close as 5%; *on engine foundations*, as close as 10%; on *circulating-water systems* as close as 15%; *on piping systems*, as close as 20%; *on condensers, auxiliaries and foundations*, as close as 3%.

Applying these percentages of error to the minimum percentages of the whole, he has the total probable error on 72.35% of the apparatus as follows:

Boilers	17.25 x 0.03 = 0.52%	(plus or minus)
Engines	33.60 x 0.06 = 2.01%	(including foundations)
Piping	7.00 x 0.20 = 1.40%	
Condensers	10.00 x 0.03 = 0.30%	
Circ.-water system	4.50 x 0.15 = 0.68%	
Total		4.91%

He assumes, for discussion, that one must estimate on the total cost as close as 15%, which percentage ordinarily includes 5% for contingencies and errors. By concentrating attention on the five principal groups, he thinks he can come as close as 5% on the larger items, and has then a leeway of about 13.5% on the remaining items. He believes it possible, in almost every case, to come within 20% on these items, and then the total estimate is within 8.5%, as against the 15% assumed.

Buildings for this apparatus vary from 6% to 16% of equipment costs, an average, say, of 10%. Using unit prices, *on a square- and cubic-foot basis*, as well as, for *hp. and kw. bases*, checking each against the other, he thinks enables him to keep his error within 10 to 15%, or 1% or 1.5% on the total.

In his practice he has used the minimum percentages for the principal items. In some cases this is as high as 85%, and by analyzing this in the same manner as for the 72.35% the total estimate may be within 6.5%.

In order to secure accurate costs for the principal items, his concern has spent some considerable money and time. These data are kept up to date, in the form of curves, tables, charts, etc., which show total and unit costs for each item and for the whole. The advantages derived from the use of these data are claimed to have paid many times over for this expense. Referring to one contract recently finished, he states that the final figures from the cost analysis show that the estimate was in error less than 2.5%.

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Steel and Concrete Fence Posts*

Only two railways make mention of having used metal posts, and these but to a limited extent. In one case bar iron ¼x2 in. was used, and in the other old boiler tubes. We believe, however, that a number of roads, are trying a metal post. Several styles of steel right-of-way fence posts are on the market. Their exploitation has just begun in the last year or two. Greater experience may demonstrate their utility, but thus far we have no data upon them.

Concrete Posts—The concrete post seems at present to offer the only solution of the problem of a substitute for wood posts. In order to secure a post of such weight that it can be handled readily (practically as easy as wood), steel reinforcement is necessary to allow a reduction in the bulk of concrete. It has been demonstrated that while concrete posts are not as strong as wood posts, yet they are sufficiently strong to meet all practical conditions. Wood posts are stronger than necessary, rather than that concrete posts are not strong enough. Furthermore, there is quite a period of time in the case of wood posts before they have decayed to such an extent as to actually require renewal, during which they are no stronger than, in fact, not as strong, as a properly designed concrete post. Not more than a dozen railroads are using concrete posts at this time in large quantities, but a large number are pursuing the subject with a view to their extensive use.

CONCLUSIONS—1. Concrete posts are practical, economical and a suitable substitute for wood.

2. Reinforcement should be placed as near to surface of post as possible; ½ in. from surface is best location.

3. Post should taper from base to top.

4. Post should not be less than 5½ in. at base and 4 in. at top.

5. Concrete should consist of 1 cement to 4 run-of-pit gravel; or 1 cement, 2 sand and 4 parts screened gravel or crushed rock of low absorption. Gravel or crushed rock not to be smaller than ¼ in. nor larger than ½ in. Concrete should be of a quaking consistency.

6. Molds should have a vibratory motion while concrete is being introduced to compact it and smooth up surface.

7. Posts should not be made out of doors in freezing weather. They should not be exposed to sun, and should be sprinkled with water the first eight or ten days after being made to aid curing.

8. Molds should be carefully oiled or soaped to provide a smooth finish and to prevent concrete sticking to mold.

9. Posts should be cured for not less than 90 days (when cured naturally) before being set or shipped.

10. Posts should be carefully handled and be packed in straw, sawdust or other suitable material for shipment.

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Crushing Tests of Steel Balls at the German testing laboratory in Gross-Lichterfelde showed an ultimate strength of 31,500 lb. for ⅝-in. balls and 49,500 lb. for ¾-in. balls; the former were somewhat harder than the ¾-in. balls. The tests were made to compare English and German balls; the tests showed them to be of equal quality. The Rudeloff method of testing was used, three balls being superimposed between the platens of the testing machine.

*From the report of the Committee on Signs, Fences and Crosings, presented at the annual convention of the American Railway Engineering Association, Chicago, Mar. 18-21.

EDITORIALS

A Revival of Old-Time Railway Promotion Methods

Many of the old-time readers of ENGINEERING NEWS can recall the palmy days of the railway-promoting business; and the eloquent orators of the Col. Sellers type whose business it was to secure local aid from cities and towns along the route of a proposed road. Sometimes the aid given was merely the giving of a free right-of-way and depot grounds; sometimes an outright gift of cash was made. Rival towns were induced to compete with each other in the offer of bonuses to obtain the road. Most often the town raised the money to aid the railway by a bond issue and sometimes received stock of the railway in return; but the cases are very few where the stock received ever became worth anything.

We are reminded of this practice by a press dispatch from Wilson, N. C., reporting that a proposed railway in that section is being promoted after the old-time fashion. The dispatch states that the township is being asked to vote bonds to the amount of $30,000 in aid of the railway, to be given in exchange for the company's second-mortgage bonds. Other towns along the line will be asked to vote on a similar basis.

It is years since any case of railway promotion by soliciting local aid has been brought to our attention; and it seems worthy of special notice as a proof that the old idea of the railway as a great public benefaction is not yet wholly extinct. It might, indeed, lead to juster views by the public of its relations to the railways, were it to reflect upon what the coming of a railway means to a community which has hitherto been isolated.

Mechanical Devices That Imitate Nerve Action

One is continually surprised nowadays by the variety of novel problems which engineers are tackling and which are often far removed from the ordinary activities of engineering. A remarkable illustration of this is furnished by a recent pamphlet written by S. Bent Russell, the well known St. Louis engineer, formerly connected with the St. Louis Water Department, which describes and illustrates some mechanical devices that Mr. Russell has worked out to imitate the action of the nervous system. Mr. Russell's own statement of what his devices will accomplish is as follows:

> We have a mechanism that can be trained, that can acquire habits, that will move either forward or back at a given signal according to experience, that will make one, two or three responses to a given signal according to experience.
>
> In other words we have shown a practical arrangement of mechanical transmitters and receivers that will respond to signals and control movements like a nervous system and that possesses associative memory as it can learn by experience.

We shall not attempt to illustrate Mr. Russell's ingenious device or to describe it further than to say that it consists of a combination of pistons and valves controlled by springs, weights, etc., and designed to be operated by hydraulic or air pressure. His purpose is to present a complete mechanical reproduction of the action of nervous impulses and thus enable them to be clearly understood. It is, of course, not pretended that the wonderful physiological mechanism of the nerve cells operates in such a way. The pamphlet is a reprint from a contribution by Mr. Russell to the *Journal of Animal Behavior* for January-February.

The thing of chief interest in the pamphlet is the extent to which engineers are attacking new problems. It must be a very difficult road indeed, and with "no thoroughfare" plainly marked across it, but some engineer will come forward and bravely endeavor to traverse it.

Fatal Electric Shocks from Lighting Fixtures

From time to time we note the recurrence of fatal accidents wherein persons come in contact with electric-light fixtures within their reach and necessarily so placed. A year ago (May 9, 1912) we showed that the number of serious accidents possibly would then total 400, with 250 fatalities, and showed how simple and inexpensive was the remedy. We have been but one of the many who have called attention to the dangers and the remedy, yet recently two men were killed in Oakville, Ont., while reaching for drop lights. During a reported three-day local reign of terror, a large number of residents received more or less severe shocks and injuries in a similar manner, so that it was necessary completely to disconnect the local distribution systems from the transmission lines in order to protect the townspeople. Five engineers were retained by the mayor to ferret out the trouble, but they were not able during the first few days of their examinations to find the sources of high potentials which resulted so disastrously and, in the last reports received, the town continued without street lights and electric service.

It is evident that in all such cases the high-tension alternating-current lines some way must be grounded and in more or less perfect contact with the low-voltage house wires, in order that a victim's body may complete the circuit for the flow of high-voltage current. We have pointed out that if the low-tension lines were grounded in accordance with the recommendations of the American Institute of Electrical Engineers and the National Electric Light Association, then no heavier potentials could possibly be impressed on any person than those carried normally by the low-tension system and even these could be guarded against.

It is criminal negligence, in view of all the studies which have been made of these recommendations, that companies should still refuse to put them into effect and continue to impose on customers this danger to life. As

we have said before, it is the duty of legislatures, commissions and councils to require this simple protection. The Washington state legislature recently demanded it.

There is one force which we have not yet heard of being applied and this may be the most effective one since it brings risk of financial ruin to the smaller concerns which probably are the most numerous offenders: this is the effect of suits for monetary damages in the civil courts, based on grounds of criminal negligence.

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Indicting High Railway Officers for Manslaughter

We commented in these columns several months ago on the flagrant injustice of indicting for manslaughter the chief operating officials of a railway company when there was nothing to show that the conditions which produced the accident on which the indictment was based were brought about by their negligence. Additional force to what we then said is furnished by the indictment last week of President Mellen and Vice-President E. H. McHenry, of the New York, New Haven & Hartford R.R., for manslaughter because of the wreck at Westport, Conn., last fall.

As our readers will recall, this wreck was due to an engineer of a fast passenger train, who was endeavoring to make up time, running past a danger signal and taking a crossover switch at a speed so high that the train was derailed. The only conceivable theory on which the president and vice-president of the company could be held in any degree morally or legally responsible for the accident, is on the ground that they were criminally culpable in not having installed crossover switches of easier angle; but it is an open question, on which different opinions are held by experts, as to whether crossover switches of easier angle, which may be taken at higher speed by trains, are really conducive to safety in operation as compared with ordinary switches.

It is true that the New Haven road, in obedience to the recommendation of the Interstate Commerce Commission, is now undertaking the lengthening of all its crossovers used by high-speed trains, involving the rebuilding of 78 crossovers, the reconstruction of 12 important switch leads which are not included in crossovers, the remodeling or rebuilding of 36 interlocking plants, and changes in signal apparatus made necessary by the above, all at a total expense estimated at $1,100,000. The new crossovers will use No. 20 frogs, over which it is estimated that trains can be run with reasonable safety at a speed of 30 to 40 miles an hour.

The New Haven officials authoritatively deny, however, that this change is being made in the belief that any greater safety will be secured by the longer crossovers. The sole advantage they expect is that somewhat higher speeds will be possible, since the train speed will not have to be slackened as much at a crossover. It is questionable whether there is not an absolute reduction in safety in permitting engineers to take the crossover of easier angle at higher speed. A wreck is still possible at either crossover if too high speed is attempted; but a wreck on a long crossover at 60 miles per hour would be more disastrous than one on a short crossover at 30 miles an hour.

We cannot too emphatically condemn the injustice in the indictment of President Mellen and Vice-President McHenry. If by holding a responsible executive position in railway service, a man is rendered liable to criminal indictment, not merely for mistakes in judgment in connection with the use of safety appliances and methods of operation, but for what legislators and lawyers who know nothing about the science of railway operation may conceive to be errors in judgment; if railway officers are to be subject to such risk, then few men of ability will care to accept such positions. Indeed, one hears the opinion frequently expressed by railway officers nowadays that they will put their sons into any other line of business in which an honest living may be earned rather than bring them up to the work which they themselves have followed.

The point which deserves most emphasis, however, is that public safety in railway travel is actually being jeopardized by such misuse of the processes of law. The officers of railways are just as much engaged in serving the public as any judge, or legislator, or district attorney, or congressman, or governor of a state and we believe the average railway officer is more competent to perform his job than the average legislator is to perform his.

As we have often insisted in these columns, progress toward greater safety in railway or industrial operations can only be secured by working with the aid of expert knowledge. Amateur meddling with the matter is likely to create ten new dangers for every one that it removes. An example of such amateur meddling by legislators is the bill just passed in New York and New Jersey fixing the number of brakemen which railways must employ on trains. This bill is enacted under color of protecting the public safety. But every railway officer knows that a train's liability to accident is not reduced by increasing the number of brakemen on the train. The air brake, which placed the control of the brakes in the hands of the engine runner, did away with any excuse for such legislation.

Another example of meddling legislation threatening public safety is a bill which was introduced in the recent New Jersey legislature forbidding railways to test the fidelity of their engine-runners in the observance of signals without giving the engine-runners notice beforehand when the test was to be made. It has been said that it would be quite as sensible to require by law that a cashier or bookkeeper must be given previous notice before his cash was counted or his books inspected.

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A "Fair Rate of Return" for Public Utilities as Affected by "Unearned Increment"

In regulating by public authority the rates charged by public utilities, there has been an evident attempt to follow as a fundamental guide the rulings of the United States Supreme Court (given in a long line of decisions well summarized in the famous Consolidated Gas case) that there should be a fair return on the property actively and necessarily employed for the public convenience.

The interpretation of "fair return" or "actively and necessarily employed" has proved in each case a specific problem and a delicate task. However, it has involved the study of business details, rather than fundamental principles, and whenever an open-minded and consci-

entious commission has been secured, seemingly all parties have eventually been satisfied that a sufficiently close approach to real justice has been secured.

But there has remained still a basic problem for those who were inclined to make a literal application of the principle laid down by the Supreme Court. This is such a fundamental problem that no mere scrutiny of business or evaluation of property has thrown light on it. So long as the capitalization of a public utility company was greater than the value of its property (including certain intangible elements, like cost of franchises and organization, engineering and contingencies, bond discounts, etc.) the regulative bodies could proceed with relatively easy minds, for fair value on the property merely meant a somewhat reduced return on the more or less inflated capital.

But when the value of the property has greatly exceeded the capitalization, the question has arisen as to the justice of fixing rates which would yield a dividend of perhaps ten or twenty per cent. or more to the holders of the stock. The opinion of the Court above noted is plain; but there can be no doubt that public opinion, which cannot be ignored, would generally oppose such rulings as unduly favorable to capital.

Recently the Massachusetts Board of Gas & Electric Light Commissioners has attacked this problem and the result is shown in two decisions now at hand. In the earlier opinion, that in the case of the Haverhill Gas Light Co., dated Dec. 31, 1912 ,the pronouncement was somewhat hesitant and reserved, but still prophetic of the more emphatic statements to follow in the second case—that of the Attleboro Gas Light Corporation, dated Feb. 7, 1913.

Following are a few extracts from the Haverhill decision:

> The company contended that a fair price should cover its operating expenses, an allowance for depreciation and a fair return upon the value of its property at the time the controversy arose,. including its franchise and privilege; that such value may be proved by actual cost and reproduction cost of its property and amount and market value of its stock and bonds; and that the fixing of a price which will not afford a fair return upon such value amounts virtually to a taking from its owners. Taking the actual cost of manufacture and distribution at 62c., allowing 8c. for depreciation and a return of 22c., or 6% on $900,000, for the value of its property, and annual sales of 250,000,000 ft., the company claimed that a fair present price for gas would be 92c., and that the reduction in cost which might come with an increased output was already anticipated in the price of 85c., which it had offered.
>
> The city urged that the fair price for gas depends upon (1) the cost at the burner (including a proper allowance for repairs, renewals and depreciation), and (2) a capital charge based upon the capital stock, and not necessarily upon the value of the property owned by the company. Using the figures of cost stated above and allowing 3½c. a thousand, or a return of 10% upon the capital stock outstanding, it suggested that 60c. was a fair and liberal price.
>
> The questions of law and public policy raised by these claims are of great importance, and were argued on both sides with conspicuous ability.
>
> It will be noted that the city's claim makes no provision for a return upon the debt to be incurred for the admittedly necessary reconstruction and extension of plant by the present owners. A fair allowance for this, however, fails to reconcile the difference between the parties. This difference seems to rest primarily on a radically different conception of the law applicable to a case where there is such an exaggerated disparity of capital stock to assets, and in which these assets have been accumulated in such large measure from earnings. Based only upon the existence of the unusual surplus and the comparison of its former prices with those now prevailing, the city alleged that the company for many years charged excessive prices, and that this extortion should not go unpunished. The company denied that its prices had been excessive, and claimed that its surplus was built up because the company refrained for many years from dividing all the earnings which might have been legally and properly declared in dividends
>
> Much was said of Massachusetts' policy with respect to public regulation, and as this policy is disclosed primarily in legislative acts, it is, perhaps, desirable to review briefly the laws by which this policy has been expressed. . . .
>
> This review of the acts of the Legislature indicates an early recognition of the business as a virtual monopoly, and imposes upon it a considerable measure of restraint, supervision and regulation. The legislative purpose to prevent the issue of stock for anything besides cash, or, in the earlier years, property actually contributed by the stockholders, is plain. The prohibition of stock dividends and the provisions for the sale of additional stock at auction, or its distribution to the stockholders at its market value, or, as now, at a price not so low as to be inconsistent with the public interest, are also indications of an early and consistently maintained purpose to prevent surpluses accumulated out of earnings becoming the basis, directly or indirectly, for the issue of stock.
>
> On the other hand, it is equally to be noted that no specific limitation has ever been placed upon rates or dividends, with a view possibly of rewarding zeal in the skillful and intelligent conduct of the business, and imposing upon the directors, subject to the check of public opinion, a consideration of the welfare of the shareholders and the equities of consumers in the surplus to which they had contributed.
>
> As market value is influenced by the rate of dividends declared, the requirement that additional stock shall be issued at a premium seems also an acknowledgment that dividends may be paid on the par of the stock at a rate in excess of the return ordinarily required by investors for the use of their money. The fact that this last feature of the law has been preserved long after an express authority was granted to this Board to reduce the price of gas is significant, too, of a legislative view that these two methods of regulation are not inconsistent. This body of legislation is plainly designed to allow no capital stock to be issued save for physical property necessary for proper corporate purposes, to keep the authorized increase of capital stock as low as market and other conditions warrant, to compel publicity of corporate affairs, and, on the other hand, to secure the community from the wasteful effects of competition by the exclusion of others from territory already adequately and efficiently supplied, and to provide, upon complaint, a compulsory reduction in price, and so to create a status favorable to low rates and adequate service. There is nothing in this legislative policy which violates or countenances the violation of the company's constitutional right to "a fair return upon the value of that which it employs for the public convenience."
>
> In deciding a complaint as to prices, the Board is bound to consider all the facts which may seem to have a bearing upon the company's affairs and the way in which it performs its public duty, but the Board is not, in its judgment, in the consideration of a proper return, required to exclude any property of the company necessary for the welfare of the public and actually used therefor, although it may have been provided by the investment therein of surplus earnings accumulated in past years; nor is it required, in order to escape the charge of confiscation, to ignore the company's history the limitations, legal or otherwise, under which its property has been acquired, or, in effect, to capitalize that property upon the same basis as if it had reached its present status under different conditions. . . .
>
> The Board believes that the price hereinafter named is fair and reasonable, and will be sufficient to cover all reasonable operating costs, a reasonable allowance for depreciation and a fair return upon the value of the property which the company is actually and necessarily employing for the public convenience. . . .
>
> The Board recommends that on and after the first day of February next the net price for gas sold by the Haverhill Gas Light Co. shall not exceed 80c. per M. cu.ft.

The second report shows that the Attleboro Gas Light Company Corporation was organized in 1898 under the general law and took over the property and business of an unincorporated association. The old association had been organized in 1859 and had taken over the property and business of a bankrupt earlier company. It began with a capital stock of $6000, which was variously increased to $16,400, although a part of the capital increase was made through a stock dividend, which was not specifically forbidden by statute. The original capital

stock of the company supplanting the association was also $46,400. In 1906, to provide for additions to plant, it increased its capital stock by the issue of 116 shares, par value $100, at a price of $225 a share, yielding in all $26,100. Although deductions amounting to $37,732 had been made for depreciation, the books show a net increase since January, 1899, of $63,582 in excess of the amount realized from the additional capital stock. The book value of the plant was then $157,373, with current assets of $35,759, or a total of $193,122, against which there were no outstanding liabilities other than the $46,400 capital stock. During this period 12% dividends were regularly paid, and in 1910 an extra dividend of 10%, claimed to represent income accumulated from the rent of land not used in its business.

In discussing the rate which is reasonable in this case, the Board makes the following comments:

> Since a company must make rates in advance, in attempting to provide for dividends and a reasonable strengthening surplus, it is impossible to see clearly and with certainty at the time what the company's business may develop. Surplus earnings so obtained have, however, quite different characteristics from those where rates are made in advance for the express purpose of providing out of profits plant investment which otherwise would come from the contribution of the shareholders. A prudent management will seldom distribute in dividends all of a company's apparent profits. Where in a brief term of years a large percentage of the plant investment appears to have been procured out of profits, or exceptionally large dividends have been declared, a suspicion naturally exists that prices have been unreasonably high, and a belief arises that the consumer has, therefore, acquired some equitable interest in such surplus.
>
> Where a company performs a public service with a proper conception of its public duty, surpluses of this character are not likely to develop. While an investment made for the public benefit may prove of public advantage from whatever source it is derived, no company ought to profit by conduct based upon a false notion of its public relations. These statements must, of course, be taken as applying to an actual and not a merely apparent surplus, although this distinction can often be correctly made only by a thorough knowledge of the company's affairs. While such surplus may be due in some measure to skill and foresight in the management, it may be and often is due in part to the general growth and prosperity of the community in which the company is located. . . .
>
> There is a growing recognition of the truth of the proposition that a public-service company is not entitled to a return upon the unearned increment in value of its real estate; but investment out of profits which it has been able to make solely through the general growth of the community which it serves has many similar attributes. It will commonly be found that a company's surplus is based on managerial skill and foresight, needlessly high rates or the general prosperity of the community, or, more frequently, on two or more of these combined; and while it may be difficult to determine what proportion is justly attributable to any one of these causes, there can be little question that the general growth of the community is an important factor.
>
> Whether because of a recognition of this principle or due to some other, it has been unlawful for many years in this state for a corporation of this class to represent its surplus in new capital by a stock dividend. It is difficult to see why the reasonable amount of return or the reasonable rate of return based upon the full value of a company's property should not be affected in the same manner by that portion of the investment made from what may be termed the unearned increment in its profits as by the unearned increment of value in its real estate. In other words, the reasonable rate of return upon a company's entire investment is lower where an appreciable part is derived from the two sources described than where it is entirely derived from the contributions of the shareholders in their payments for its stock. . . .

Acordingly the board reduced the price of gas from $1.10 per thousand cubic feet to $1. The apparently small amount of this reduction is in part explained by the commission's recognition that the present plant of the company was practically inadequate for the service and that it was under the necessity of removing its works to an entirely new site where equipment would have to be provided of a capacity which would not be completely utilized for many years.

From the foregoing it is seen that the Massachusetts Board has now gone on record as assenting to the proposition that a rate may be reduced lower than that which a fair return on the value of the company's property would require, where such a value is far greater than the par value of the capital stock outstanding. Whether that view is contrary to the Supreme Court ruling that the owners are entitled to a fair return on the actual value of their property is a question on which there may be difference of opinions.

A more direct and logical way of securing the same result would be to reduce the valuation of the property in some degree where it can be shown that the present value is to a considerable extent due to excessive rates in the past, the profits from which have been invested in the property instead of distributed as extra dividends.

It is interesting to note that in the well known case of Smith vs. Ames (160 U. S., 466), decided in 1898, Justice Harlan stated that "fair value" of property being used for public convenience was to be estimated after due consideration, among other things, of (1) "the present as compared with the original cost of construction," and (2) "the amounts of bonds and stock." If these two items showed that a valuable plant has been built up by earnings rather than wholly from investments by stock and bond holders, who had meanwhile received steadily a fair return on their investment, some deductions from the book valuation of the company's property as a basis for rate fixing would be apparently in agreement with the Court's decision.

The New York Public Service Commission for the 1st District has also made a ruling recently which is worthy of note. It will be recalled that in the Consolidated Gas case (212 U. S., 19), while the ruling was that the actual value of the property at the time (including increase in value of property since acquired) was to be the basis of rates, the Court was careful to state that there might be exceptions not seen from the facts in the case at issue. The New York Commission ruled in the Kings County Gas Light Co. case (see ENGINEERING NEWS, Nov. 16, 1911) that this decision was not found to give that company the right to base earnings on an increment of value in pipe lines due to new pavements having been built over them at the city's expense.

There are other cases which might be cited to show that not only is the fair value for rate-making purposes not necessarily the complete actual value at the moment, but that among the reductions properly made is such a one as is above proposed.

In dealing with all these matters it must be remembered that a reasonable "statute of limitations" must be applied. It will be unwise and impracticable in nearly every case to attempt to unravel the complicated financial operations of the past. We cannot justly demand that the gas and water and street-railway companies, which reaped big profits in the days when all these industries were conducted as a private enterprise, shall now make accounting for those profits or shall today be content to do business on lower rates because they invested extra profits in their plant instead of distributing them like their neighboring companies as extra dividends.

LETTERS TO THE EDITOR

A Heavy Rainfall at Richmond, Ind., During the Recent Flood Period

Sir—Relative to the Ohio and Indiana floods, you may be interested in the following rainfalls observed by the Richmond Water Co., at Richmond, Ind., on Mar. 23 to 27, 1913.

Richmond is located near the headwaters of the Indiana and Ohio streams on which the greatest damage was caused by the recent floods.

	Inches
Mar. 23, 7 a.m. to 5 p.m.	0.88
Mar. 24, 3 a.m. to 12 midnight	5.30
Mar. 25, midnight till p.m.	4.17
Mar. 26, noon tomidnight	0.76
Mar. 27, midnight to 4 p.m.	0.04
Total	11.15
Total for the month of March	12.89

As will be noted, the result of the excessive rainfalls on Mar. 24 and 25 was accentuated by a heavy rain on the 23d. Up to the 23d the rainfall for the month had been slight, and it is said that there was no frost in the ground at Richmond at this time, and very little during the entire winter.

CHAS. B. BURDICK.

Hartford Bldg., Chicago, Ill., Apr. 7, 1913.

Azimuth by Direct Solar Observations

Sir—I was pleased to see the article by Mr. Ross, in the issue of Mar. 6, advocating a more general use of direct solar observations for checking the azimuths of a survey. Such suggestions as this coming from men in practice are likely to have more weight with the practicing surveyor than when they come from the textbooks.

I have used direct solar observations for many years and appreciate their value in dealing with long traverses. For this reason I can heartily indorse Mr. Ross's claim for the method. The particular manner of making the observations or of working up the results is to some extent a matter of taste. A judicious combination of natural and logarithmic functions has always seemed to me desirable. The more common formulas are intended for logarithmic computation only.

In discussing the matter of sun observations the question has often been raised whether it is sufficiently accurate to bisect the sun's disk with both cross-hairs rather than to take separate pointings on the edges. I have often used the bisection method, taking but one pointing when pressed for time, and have always been satisfied that the result was within 1′ of the true value, judging from the checks on the azimuths of the survey. I never really tested the matter, however, until last spring. On May 24, 1912, I took several readings of altitude and azimuth with a transit reading to 1′, bisecting the sun's disk each time with the vertical and horizontal cross-hairs, having no stadia or other hair as a guide. The readings are as follows:

	Horizontal	Vertical	Deviations in horizontal
(1)	56° 51½′	44° 50½′	—0.1′
(2)	57° 10½′	44° 34′	0.0′
(3)	57° 23½′	44° 23½′	+1.0′
(4)	57° 34½′	44° 13′	0.0′
(5)	57° 46½′	44° 02½′	—0.2′
(6)	58° 00′	43° 50′	—1.0′
(7)	58° 11′	43° 42′	+0.8′
(8)	58° 24′	43° 30′	0.0′
(9)	58° 35½′	43° 19½′	—0.7′
(10)	58° 47′	43° 10′	0.0′

Plotting these on cross-section paper and drawing a straight line so as to fairly represent the points (neglecting the small correction for curvature), the deviations from this line for the separate horizontal circle readings are given in the column on the right.

The mean is less than 0.4′ and the maximum is 1.0′. This would seem to indicate that if the azimuth is desired only within 1′ the bisection method is sufficiently accurate. These pointings were made under average conditions and consequently represent what might fairly be expected in practice. I have usually hesitated to recommend this method to beginners as it seemed liable to lead to careless habits of observing. The results, however, seem to show that it is worthy of consideration.

GEO. L. HOSMER.

Massachusetts Institute of Technology.

Mar. 15, 1913.

Rate of Rainfall for Storm-Sewer Calculations: Experience of Pawtucket, R. I.

Sir—Referring to the article entitled "Rates of Rainfall for Storm-Sewer Calculations" by J. A. Cushman, in ENGINEERING NEWS of Apr. 10, 1913, the undersigned is very much afraid that the engineer who, today, designs storm-water sewers for a maximum rainfall rate of 0.5 in. per hr., is going to get into serious difficulty and will later be called to account for having constructed sewers of insufficient capacity.

The writer feels that Mr. Cushman has confused two entirely independent facts, namely the *total quantity* of rain falling within 1 hour and the *rate of precipitation* expressed in inches per hour, but lasting only a fraction of that time. It is these latter figures, the *rate of precipitation* in inches per hour, lasting for periods of perhaps 10, 20, 30 or 40 minutes, that are of vital interest to the engineer in the design of storm-water sewers.

Mr. Cushman states, in the article referred to: "a rate of over 1 in. of rain falling in an hour is an exception * * * and that a storm of over 1¾ in. per hr. is a rarity."

The writer has made observations of rainfall, extending over a period of eleven years, studying the rates of precipitation of each storm by means of an automatic record of the storm itself. During these eleven years the records show that there have been only 7 storms with a total precipitation of 1 in. or more within an hour, but that there have been more than 90 storms during the

same period that have given *rates of precipitation* greatly in excess of a rate of 1 in. per hr.

No less than 19 of these storms recorded rates in excess of even 2 in. per hr. and a maximum record is a rate of 5.2 in. per hr., lasting for a period of 10 minutes. During this same eleven years only 3 storms gave a total precipitation of over 1¾ in. of rain within an hour, but 20 showed a *rate of precipitation* of over 1¾ in. per hr., lasting, of course, much less than 60 minutes.

Mr. Cushman writes that "engineers are using McMath's formula which, although it takes the rate of rainfall into account, is based on a rate of 2.75 in. per hr. and leaves no opportunity to reduce or correct this rate." While the writer much prefers the so called "rational formula," $Q = Acr$, used in connection with a rainfall curve, he feels that the McMath formula *does* afford an opportunity for the engineer to exercise his judgment and discretion in the assignment of values for r and S.

GEORGE A. CARPENTER,
City Engineer.

Pawtucket, R. I., Apr. 12, 1913.

Lessons and Opportunities of the Recent Floods

Sir—As the mighty flood of last month coursed down the river channels of the northern half of the Ohio valley, leaving naught but ruin and disaster in its wake, it carried on its yellow bosom the secret of many floods of years long past. Knowing no law save that of gravitation, it followed the broad, well beaten path of its ancient predecessors, and at all points where this path had not been modified and constricted by the works of man, it did little harm and wrought little change. But wherever a road, a bridge, a house, a city, a town or other work not harmonizing with the topography, had been built, the waters at once proceeded to exert their strength and make manifest their energy. As in the case of a lightning discharge, the greatest damage was done along the line of greatest resistance.

The topography of the valleys of these streams bears eloquent evidence that there have occurred in the past greater floods than the one which is now uppermost in the minds of all, and, moreover, the testimony written on the hillsides is clear that there have been many such floods. How many centuries ago and how often they have occurred we know not. Of only one thing are we certain, and that is that the flood plains on which most of the larger and many of the smaller cities and towns throughout this region are built, were themselves laid down by many floods. And when the manifestations of this most recent of them all are carefully examined, one cannot help stopping and wondering whether, after all, it is necessary to go back to glacial times in order to find a source and supply of water sufficiently great for producing many of the effects which have generally been attributed to the melting of the great ice sheet. It seems almost as though present-day agencies of themselves, if they occur only in proper combination, are amply sufficient to account for some at least of the dynamic effects which most usually are ascribed to the waters of the melting glaciers. Consider for a moment what proportions this flood might have assumed had there been a foot of snow on the ground when the rains came, and had the ground been frozen!

It is of importance for the future to know whether other floods perhaps of even greater magnitude are likely to occur and in order to make the most of every shred of evidence, it behooves the engineer to look about him and read the signs. Before the white man went into the Ohio valley, it was inhabited by the North American Indian who bequeathed to posterity no records and few legends. But before the Indian, this same country was occupied by the Mound Builders, who left behind them many traces of their civilization and many works of large magnitude. Baldwin's "Ancient America" speaks of these works as follows:

> None of the works, mounds and inclosures are found on the lowest formed of the river terraces which mark the subsidence of the streams, and as there is no good reason why their builders should have avoided erecting them on that terrace, while they raised them promiscuously on all the others, it follows, not unreasonably, that this terrace has been formed since the works were erected.

May it not have been, however, that these peoples had a better knowledge of these streams than do we of the present, and so took good care to build their works above the floods? Or if they did build on the lower terrace, may not all of the structures so built have long since been washed away?

In this connection, it has occurred to the writer that valuable information may be gathered by the engineers of Ohio and Indiana if they will but look into and examine the relation between the high-water marks of this recent flood and the mounds and structures which antedate all other works of man of which we have knowledge in this region. If this flood reached up to and into these old mounds and inclosures, and did damage to them where before there had been none, it would necessarily follow, all other things being the same, that this flood was greater than any which occurred since their construction. On the other hand, however, if the waters did not reach the mounds, it would seem as though this last high-water did not rise to an elevation as great as that which these architects of olden days considered necessary for the safety of their structures, and consequently it may well be inferred that many higher waters than those of the present have flooded these valleys since the days of the activities of that great but long since extinct people who were the first on this continent to leave behind them works of an enduring nature.

To the people of the present it is of the greatest importance whether their residence on the flood plains of these streams is one of permanence and safety, and for this reason it may well be that evidence of this nature from the distant past may serve for them a most useful purpose. It is the hope of the writer that examinations of the kind suggested will be made and that the results thereof will be set forth in the columns of your valuable paper.

JUPITER PLUVIUS.

New York, Apr. 16, 1913.

Wind Stresses in Buildings

Sir—I have read with interest the article in your issue of Mar. 13, 1913, "Wind-Bracing without Diagonals for Steel-Frame Office Buildings," by Mr. R. Fleming. The subject is one phase of structural steelwork on which there has been too little published, and it is a distinct service to the profession to make public the methods in use in good practice.

The writer has been giving his students in "Tall Build-

ing Design" a slight modification of Method III for the past seven years.

The statement of the author at the end of his description of Method III that "The horizontal shears taken by the columns will vary as their section moduli," should read "moments of inertia" instead of "section moduli." The proof is as follows:

Fig. 1 herewith represents the elastic lines of one story of a steel-frame building with rigid joints, under wind loads only. It is assumed, as in Mr. Fleming's article, that the longitudinal deformations of the members may be neglected and that the points of contraflexure are at the mid-lengths of the members, or, stated differently, that the tangents to the elastic lines at the two ends of each member are parallel to each other. Fig. 2 shows the elastic line of Col. No. 1 for any story.

H_1 = The shear in the column;

M_1 = Bending moment at the ends;

M_x = Bending moment at any point whose coördinates are x and y, the origin being taken at the bottom of the column.

The differential equation of the elastic line is

$$E I_1 \frac{d^2 y}{dx^2} = M_x = M_1 - H_1 x \qquad (1)$$

Integrating this twice we get

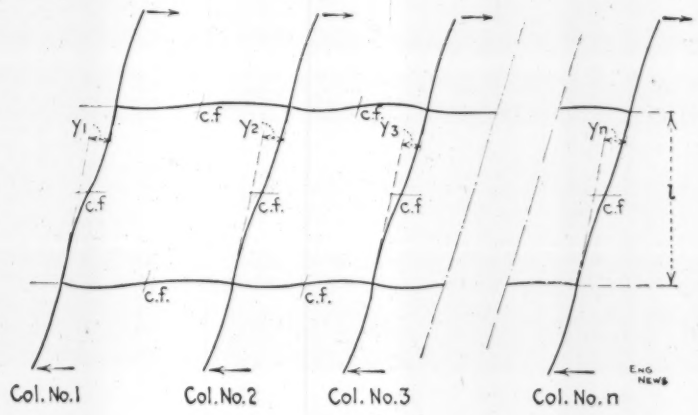

FIG. 1

$$E I_1 y = \tfrac{1}{2} M_1 x^2 - \tfrac{1}{6} H_1 x^3 \qquad (2)$$

When $x = l$, $y = y_1$, which is the deflection of the top of the column with respect to the bottom (see Fig. 1)

$$E I_1 y_1 = \tfrac{1}{2} M_1 l^2 - \tfrac{1}{6} H_1 l^3 \qquad (3)$$

Taking moments about the point of contraflexure in Fig. 2 we get $M_1 = \tfrac{1}{2} H_1 l$, which substited in equation (3) gives

$$E I_1 y_1 = \tfrac{1}{12} H_1 l^3 \qquad (4)$$

Similarly, the deflections of the other columns may be written

$$E I_2 y_2 = \tfrac{1}{12} H_2 l^3$$
$$E I_3 y_3 = \tfrac{1}{12} H_3 l^3$$

and

$$E I_n y_n = \tfrac{1}{12} H_n l^3$$

From the original assumption that the longitudinal deformations are negligible, i.e., that the shortening of the girders due to the direct compression in them may be neglected, we know that

$$y_1 = y_2 = y_3 = y_n \qquad (5)$$

Then,

$$\frac{y_1}{y_2} = 1 = \frac{\frac{H_1}{I_1}}{\frac{H_2}{I_2}}$$

which gives

$$H_2 = H_1 \frac{I_2}{I_1}$$

Similarly

$$H_3 = H_1 \frac{I_3}{I_1}, \quad H_n = H_1 \frac{I_n}{I_1}, \text{ etc.}$$

But $H_1 + H_2 + H_3 + \ldots . H_n = S =$ total shear in all the columns of that story.

Substituting the values of the H's

$$S = H_1 + H_1 \frac{I_2}{I_1} + H_1 \frac{I_3}{I_1} + \ldots . H_1 \frac{I_n}{I_1}$$

$$= \frac{H_1}{I_1} (I_1 + I_2 + \ldots . I_n)$$

Hence

$$H_1 = S \frac{I_1}{I_1 + I_2 + I_3 + \ldots . I_n} = S \frac{I_1}{\Sigma I}$$

Similarly

$$H_2 = S \frac{I_2}{\Sigma I} \text{ and } H_n = S \frac{I_n}{\Sigma I}$$

It is the writer's opinion that Method III is more rational than either of the others, although all of them are open to the criticism that the assumptions made are not in accord with the facts.

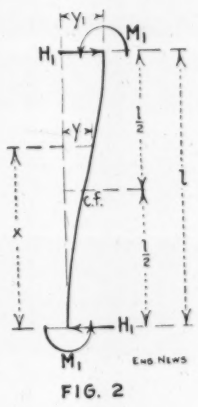

FIG. 2

Mr. Cyrus A. Melick, D. C. E., made a complete investigation of this subject, both analytically and by extensometer measurements on a 16-story building, as a thesis for his doctor's degree at the Ohio State University in 1909 and 1911. This thesis has been published as a Bulletin of the College of Engineering. The conclusions of Mr. Melick were that the rigid solution was entirely too long and cumbersome for use in practice and that some such approximate method as is given by Mr. Fleming must be used.

Mr. Fleming's note that "Special attention should be given the column splices and the connections of the floor girders to the columns," should be given special emphasis, for many buildings are built in which these details are entirely inadequate to develop the strength of the main part of the member and to give the required rigidity at the joints. It must be remembered that frequently the maximum bending moments in the girders occur at their connections to the columns.

CLYDE T. MORRIS.
Professor of Structural Engineering, Ohio State University.
Columbus, Ohio, Mar. 22, 1913.

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Federal Control of River Regulation

Sir—I have read with great interest, in ENGINEERING NEWS of the issue of Apr. 10, your editorial and Rudolph Hering's communication on the subject of river control and the prevention of floods, and in the main agree with what was said therein.

Any project of this kind would be of enormous magnitude, complication and importance, and should not be entered upon without great deliberation and the most careful study and consideration. There is danger that

the recent great calamities from floods, and the public sentiment created thereby, may incite the National Government to ill-considered undertakings that are not warranted by sound engineering, economic and financial reasons.

The new Secretary of War, whose high character and signal ability in his own professional field no one questions, is reported to have said that the Government must undertake immediately remedies against a recurrence of these disasters. If this means that Congress is to be urged to authorize at once such work, and to make adequate appropriations to begin and carry out the physical improvements that it may hastily judge to be necessary, it will almost certainly be unfortunate, and will probably result in the squandering of enormous sums of money.

The only rational and safe way to proceed in the matter is that suggested by you and by Mr. Hering—the most careful and deliberate study of the problems involved, by the ablest talent in the country, and the formulation of the best measures to meet each individual locality and case. If Congress could be induced to make at once a rational beginning by the creation of a commission composed of able engineers and others, and to provide it with the necessary authority and means to prosecute its work, we might expect to make real, and in the end, most rapid progress toward the solution of the various problems involved.

I use the word problems intentionally. The engineering, economic, governmental and financial questions involved have not, in this country, advanced beyond the problematic stage. Nor are these problems so simple here as one might infer they are abroad, from Mr. Hering's rather optimistic statements. While the questions that must be considered are primarily of an engineering nature, they involve different problems of constitutional law, economics and statesmanship that cannot be ignored.

The question, how far the National Government is authorized or warranted under our Constitution to undertake work of this character is, alone, one of tremendous importance, and one which there seems to be a strong tendency, in these days, to ignore. The only authority conferred upon the National Government for undertaking public works, for other than military purposes, found in that fundamental instrument, is contained in Section VIII, and reads: "To regulate commerce with foreign nations and among the several states and with the Indian tribes." It is generally accepted that this implies the right and duty of the National Government to undertake the development of physical projects necessary to provide for and to facilitate foreign and interstate commerce; but up to the time of the Civil War the opinion was quite generally and consistently held that it does not authorize or permit the National Government to engage in improvements that are of purely intrastate or local character, having no tangible connection with interstate commerce. The earlier Presidents generally vetoed measures of this questionable character passed by Congress, and the unanswerable reasons and arguments advanced in these vetoes are well worth reading and pondering today.

More recently the Government has either read into this provision more than it was evidently intended to mean, or has ignored it; and there exists today an alarming tendency for Congress to authorize and provide for, and for presidents to approve, projects that are wholly intrastate and local, such as the construction of highways, the drainage of swamp lands, etc., and now we shall probably have bills passed to undertake the local protection of cities and towns from floods. Before we engage in such a stupendous enterprise, with all that it involves, should not this question be considered and decided by authorities more competent to judge, and more disinterested than the members of Congress?

Other important questions involved are: If the cost of such improvements is to be partly met by the national and partly by the state governments, how is the relative amount to be paid by each to be determined? What part of the cost shall be met by the municipalities directly affected? Who shall design and construct the necessary works, and be afterward responsible for their care, maintenance and police control?

From the economic standpoint, to what extent is protection warranted against floods that occur only at long intervals and who shall decide this question? Outside of towns and cities, and excluding the lower reaches of the great rivers, flood damages are comparatively insignificant. To what extent may these towns and cities reasonably be required to work out their own salvation?

Consider the upper Ohio River and its tributaries. It is still an open question whether adequate storage reservoirs to control floods are practicable or even possible. Any scheme of channel enlargement that would greatly reduce the flood heights, except at a cost that would be absolutely prohibitive, is easily shown to be futile. Might it not be cheaper and better to construct local levees; or even to condemn and abandon the urban property subject to destructive floods, rather than to attempt any effective project for reducing flood heights? If so, shall the National Government undertake to do such local work, and bear the cost of it?

These are only a few of the questions outside of engineering questions proper that must be considered and decided before any general scheme of river regulation and flood protection can be safely adopted. They involve work for the engineer, the constitutional lawyer and the economist, who should all be represented on the Commission suggested.

S. WHINERY.

95 Liberty St., New York City,
Apr. 15, 1913.

NOTES AND QUERIES

In the article on "The Flood of March-April, 1913, on the Ohio River and Its Tributaries," by John C. Hoyt, in our issue of Apr. 10, 1913, the last sentence in the first paragraph on p. 753 should have read:

For the 10-day period from Mar. 26 to Apr. 4, about 12,100,000 (instead of 12,100) acre-feet passed Cincinnati.

A correspondent raises a question as to the correctness of the statement in the foot note to p. 506 (Mar. 13, 1913, article on "Surplus Waters of the Los Angeles Aqueduct") that a California miner's inch is equivalent to 12,960 gal. a day. While it is true, as our correspondent states, that the statutory miner's inch in California is 1.5 cu.ft. per min., we understand that in the Los Angeles Aqueduct calculations, a value of 1.2 cu.ft. per min., which is commonly used in southern California, is employed.

Dayton After the Flood

(EDITORIAL CORRESPONDENCE)

Dayton, Ohio, Apr. 15—Dayton is excessively dirty. It seems as though little progress had been made in cleaning up, though of course much has been done. Only the main business streets are cleaned fully (except for muddy gutters), and the secondary business streets are so full of débris and dirt outside the street-car and driveway width as to make it necessary to walk in the middle of the street in many places. There is a general smell in the city, and the food seems to taste almost as slimy and creosoty as the smell smells. The water was about 9 ft. deep on the sidewalk here at Third and Main.

The breaks in the levees have all been patched up temporarily to hold a 15-ft. stage in the river. The tops of the levees were at +23, new city datum. The flood-crest elevation has been given by the Engineering Department as 29. The flood record of 1898 was stated as 20.2, and

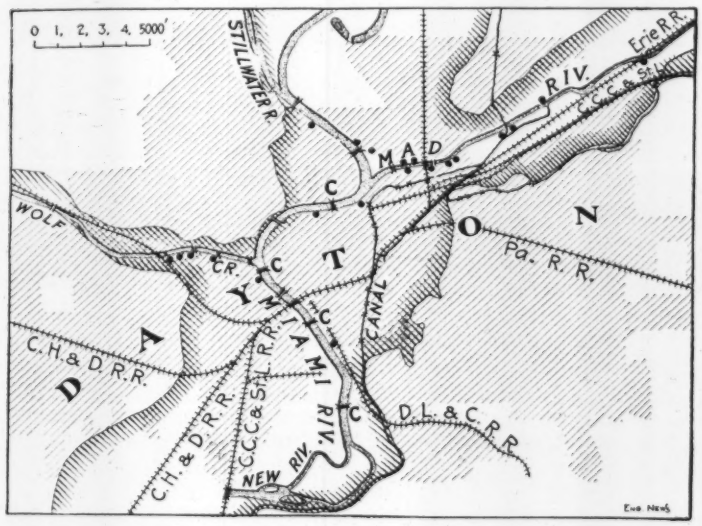

FIG. 1. MAP OF DAYTON, OHIO

(Built-up area hatched and the flooded area outlined by cross-hatching. Levee washouts shown by small black circles. Concrete bridges by letter C. The second bridge below Mad River, at Monument Ave., is also of concrete, though not so marked in the cut.)

the idea was to raise the levees to an elevation of 3 ft. above that flood. Low water is about 3.25. The levee tops were *supposed* to follow the high-water slope of the 1898 flood, but I do not find that anyone knows what this was. Surveys are now being made by the Relief Commission's office to get high-water elevations, slope, etc.

No topographic map of the city, except the 20-ft. contour, U. S. Geological Survey map, appears to be in existence and no longitudinal profile of the valley. Apparently, there is no definite basis on which to estimate the volume of flow in the recent flood. All are content to leave this in the hands of the newly-appointed board of U. S. Engineer officers, and they expect from that board the direction of their future work as to levees and flood protection. The sentiment is in favor of submitting to and accepting whatever this board determines.

The river is on the average about 600 ft. wide between its banks here in Dayton, and its maximum flood depth was about 28 or 30 ft. Its slope was probably nearly the same as that of the Muskingum at Zanesville.

For the present the engineering department of the emergency city government is going to repair the levee washouts to the original height, and will do nothing farther in levee work. Many of the levees had riprap or stone revetting, but of course this was on the water side only. The fact that overflow occurred all along the levee, as indicated by the breaching, probably does not suffice to show close agreement of the 1898 and 1913 flood slopes.

The Dayton Union Ry. Co. bridge piers, which were in part washed out, were founded about 7 ft. below river bed on grillage on gravel. The piers of the city bridges went somewhat deeper, about 10 to 13 ft. below river bed, most of them on gravel, but one or two on hardpan; and a few of the deeper ones had to be carried down to get below sand into gravel. None of the city bridge piers in the Great Miami scoured out, while the railway bridge lost at least two of its piers in this way. One

FIG. 2. HIGH-WATER IN DOWNTOWN DAYTON

pier of the Helena St. bridge over the Stillwater has disappeared; this was a light road bridge giving access to a city park.

The county (Montgomery) lost several large and many small bridges or culverts. The loss of the large bridges is appraised at $700,000. The largest bridge lost is the lower Miamisburg bridge, three 200-ft. steel-truss spans. None of the county's reinforced-concrete bridges went out; the largest of these was 120 ft. long, two 56-ft. spans. Under date of Apr. 8 the report of County Engineer E. A. Moritz stated "The Commissioners contemplate replacing with concrete steel structures, as all concrete bridges in the county withstood the flood." But since then the people of Miamisburg have objected to a concrete bridge, and want a suspension bridge to get all the waterway possible. Two bridges went out at that town, and one is to replace them.

As an idea of the behavior of some bridges that stood, it is stated that at Preble, on the Warren County line, a through truss bridge over Twin Creek with two 150-ft. spans had water 4 ft. over the floor but did not go out. A post of this bridge was bent upstream, it is said, by a log turning over and hitting it backward.

The only highway bridges left over the Big Miami below Dayton are said to be at Franklin, Poasttown and Trenton.

The sewer system of Dayton was not much damaged, but in some districts the sewers appear to be clogged and have not yet been opened. No breaks in the sewer system are reported. The house connections were very extensively destroyed, and on this account public privies were built over sewer manholes, to the number so far of 101. Major Rhoads states that a very large number of privies existed in Dayton, probably 10,000 to 12,000 (including a certain number of abandoned ones). Under these circumstances the absence of disease is remarkable.

The city's water-supply was cut off by the flood until Sunday, Mar. 30. It was then restored by the opening of the pumping station (which draws its supply from wells in the Mad River valley). It is still considered unsafe, on account of pollution of the mains, though good at the pumps. Tests are made regularly.

The sanitary administration has been under U. S. Army Medical Corps Major Rhoads since Mar. 28 (ordered here by Garrison). The state and local health boards are subsidiary to him, at Gov. Cox's orders. When he got here, a general relief bureau was already in operation, by the Citizens' Relief Committee, including some medical relief. He organized 16 districts with a local physician as district sanitary officer in charge of each, with authority to appoint assistants, set to work men and teams to clean up, etc. The districts were subdivided into zones, with an Assistant Sanitary Officer to each; 64 Red Cross nurses assisted in work of inspection, sick service, etc. A house-to-house inspection was made over the whole flooded area by these zone organizations, and all sick were sent to the two public hospitals, abolishing all local hospitals. Subsequently, also, all suspicious sick were sent to hospitals, there being no house quarantine permitted even in the dry area, with the idea of getting the sick away from the well.

The work of cleaning-up the streets is in charge of the Engineering Department of the Citizens' Relief Committee, and the cleaning of houses and premises under direction of the Sanitary Organization by the householders, or, where these are unable to do so, by the organization forces. Some 2800 men were put to work at the cleaning right at the start. Major Rhoads states that about seven-eighths of the houses in the flooded areas are now cleaned. Schools and public buildings, etc., are cleaned out by the organization forces. Formaldehyde fumigation and disinfectant washing with cresol and chloride of lime are required, the latter being done by the householders with material furnished from United States supplies; fumigation is done by an official squad.

Garbage collection (once daily) was reëstablished Apr. 12 by Major Rhoads. Prior to that, garbage was ordered to be burned by the householders. The reduction plant has been running since the week of the flood.

The central organization was made up of a Chief Sanitary Inspector (having charge of the district organizations) and a Superintendent of Sanitation and Plumbing. The latter's first duty was to discover and stop leaks in the water house connections as soon as water was pumped, and to put up privies, etc. A supply bureau (for tools, boots, disinfectants, etc.) was also part of the central office. The Secretary of the State Board of Health is the Superintendent of Sanitation. The local health board looks after quarantine, fumigation, etc.

Two refugee camps were set up, taking care of 300 each. No more seem to need housing and feeding in these tent camps.

The sickness record today is: Diphtheria, 20 cases; scarlet fever, 8 cases; measles, 11 cases; chickenpox, 7

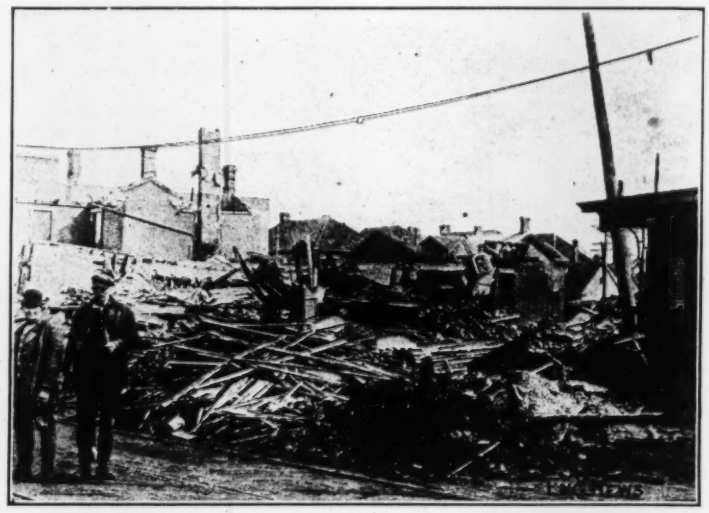

FIG. 3. VIEW ON SOUTH MAIN ST.

FIG. 4. VIEW LOOKING EAST ON FIFTH ST.

FIG. 5. LOOKING EAST FROM MAIN ST. ALONG THIRD ST. ON MAR. 26

VIEWS OF DAYTON DURING AND AFTER THE FLOOD

cases; smallpox, none; typhoid, none; mumps, some, but not reported.

Major Rhoads can offer no explanation of the absence of typhoid, as there has always been typhoid in the valley, and the washing out of privies would tend to spread it.

No hypochlorite treatment has been applied to the water; reliance is placed on the emphatic and widely published warnings to boil all water. I will write more fully in a few days.

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Railway Damage and Railway Reconstruction in the Ohio Flood Districts

BALTIMORE & OHIO SYSTEM

(From J. Hampton Baumgartner, Publicity Representative.)

The damage to the railways by the March flood in Indiana, Ohio and sections of West Virginia and Pennsylvania was without precedent in the history of transportation service. Never before had there been so complete an interruption to traffic between the East and the West.

Without exception, all of the railways in the flood districts were badly damaged. It was only the resoureefulness of present-day railroad management that made it possible to restore service on something like regular schedules within two weeks after the flood.

Railroad tracks, sidings, heavy bridges of steel, concrete and stone construction; stations, shops and terminal buildings, rolling stock, lumber and expensive materials of every sort were caried off by the torrents; and interlocking machinery, signal apparatus, telegraph lines and other property had a similar fate.

The restoration of the railways so that they could again handle passenger and freight traffic was most urgent. Famine threatened millions of people in the stricken states whose homes had been lost in the floods and whose means of livelihood had been cut off. The first efforts of the railroads were therefore directed toward relief work. As soon as temporary service had been restored, hundreds of carloads of food, clothing, medicine and other donations were rushed to the relief. Government and State troops were also taken in to maintain order.

In this emergency the railways were operated as if they were one system. The stretches of track which had escaped the trouble were used jointly by the various roads in the localities, for detouring repair gangs and operating trains as best they could. It was extremely difficult to arrange for repairing the damage to the railroads, owing to the severance of telegraph and telephone communication which made it is impossible to obtain accurate knowledge either as to the extent of the destruction or its nature. Many reports were received by way of farmhouses and, in some instances, by couriers.

The financial loss to the Baltimore & Ohio System in the floods will probably be between $2,500,000 and $3,000,000, in the belief of President Daniel Willard, Vice-President A. W. Thompson, the chief operating officer, and Chief Engineer F. L. Stuart, who have completed a tour of inspection of their lines in the flood districts.

On Wednesday, March 26, the Baltimore & Ohio announced that it would handle free all relief shipments for the sufferers and give such consignments preference. The stations, shops and other railroad buildings available were also thrown open to the sufferers for their shelter. Railroad restaurants also dispensed food gratis to those who were hungry.

When reports of the serious situation in Ohio reached Baltimore, large forces of workmen were assembled with material for repairing tracks, bridges, stations and equipment. By the time the floods had reached their crest an army of 6000 men was waiting east of the Ohio River, between Parkersburg and Pittsburgh, ready to enter the flood districts.

A conference between President Willard, Vice-President Thompson, Chief Engineer Stuart and other executives was held and an emergency organization was made effective.

Fearing that various officials would be marooned and cut off from communication with headquarters, instructions were sent out for the heads of the operating and engineering departments in the respective territories to remain at their offices and direct the handling of the workmen and material. The arrangement was carried out as to the operating department under the direction of Vice-President Thompson, General Manager Galloway, of the Baltimore & Ohio (Baltimore), and General Manager Loree, of the Baltimore & Ohio Southwestern-Cincinnati, Hamilton & Dayton lines (Cincinnati).

An emergency organization was likewise put into effect by the engineering department, with Chief Engineer Stuart in charge. The railroad was divided into districts and placed under the supervision of the engineering staff, as follows:

Paul Didier, Principal Assistant Engineer, Pittsburgh; Zanesville territory and rebuilding Zanesville bridge.

A. M. Kinsman, Engineer of Construction, Cincinnati; Indiana division, B. & O. SW., west from Cincinnati.

J. T. Wilson, District Engineer, Baltimore; B. & O. SW. east from St. Louis.

L. G. Curtis, District Engineer, Chicago; Indianapolis division, C., H. & D., including Hamilton yards and bridge.

J. D. Carothers, Special Engineer, Baltimore; Columbus district.

F. E. Lamphere, Assistant Engineer, Chicago; Louisville district and Lawrenceburg bridge.

D. R. Hundley, Assistant Engineer, Chillicothe; Chillicothe district and yards.

Claude Brown, Assistant Engineer, Chicago; Toledo division, C., H. & D., and Dayton district.

W. S. Bouton, Engineer of Bridges, Baltimore, assumed charge of the preparation of plans for the new bridges and the assembling of needed material. M. A. Long, Assistant to Chief Engineer, Baltimore, was placed in general charge of architectural matters and the designing of buildings. Besides the foregoing organization, Resident Engineers at various points on the lines have been assigned to special work in the flood districts.

The working forces are organized into day and night shifts and with 18 pile-drivers, numerous steam shovels, derricks and other machinery in operation, all double-crewed, rapid progress is being made in rebuilding the road. The floods carried away 12 bridges on the Baltimore & Ohio System, the most important being at the following places:

Zanesville, over the Muskingum River; Marietta, over the Muskingum River; Washington, Ind., over the west fork of the White River; Lawrenceburg, Ind., over the Big Miami River; Hamilton, over the Big Miami River; Brownsville, Ind., over the east fork of the White River, and Morristown, Ind., over the Blue River. Options were taken on large quantities of bridge steel several days before the water began falling and the work of restoration was further augmented by the awarding of contracts for rebuilding bridges that were lost.

The financial loss sustained by the Baltimore & Ohio System, by Districts, was approximately as follows:

Pittsburgh District	$25,000
Northern Ohio District, between Youngstown and Tiffin on the Chicago Main line	150,000
Cleveland District	200,000
Lake Erie District, between Chicago Junction and Newark, O.	100,000
Central Ohio District, including Zanesville terminals and bridge	300,000
Ohio and Little Kanawha District, between Zanesville and Marietta, including Marietta bridge	150,000
Shawnee Branch	25,000
Ohio River District, between Wheeling and Kenova, W. Va.	200,000
Southwestern District, between Parkersburg and Vincennes, on St. Louis main line, including Chillicothe terminals and bridges at Lawrenceburg and Vallonia	650,000
Columbus District	100,000
Cincinnati, Hamilton & Dayton main lines and branches including Hamilton terminals and bridge, Dayton terminals and bridge, bridges at Brownsville and Morristown, Ind., Wellston and Delphos divisions	1,000,000

In the Central Ohio District, the most serious loss was at Zanesville. The Zanesville terminals were practically destroyed, including the shops, freight station and other terminal buildings; a large quantity of high-grade lumber and other railroad supplies and material. The bridge over the Muskingum River at Zanesville was lost notwithstanding the fact that it was weighted down with 20 loaded freight cars which went down with the bridge. The loss of the Zanesville bridge resulted in a break in the main line, necessitating a transfer. A temporary bridge will be erected and traffic resumed over it pending the completion of a new steel bridge which has been contracted for.

The Ohio and Little Kanawha line between Zanesville and Marietta was badly washed at several places. The bridge at

TRACK WASHED, BETWEEN DAYTON AND MIAMISBURG

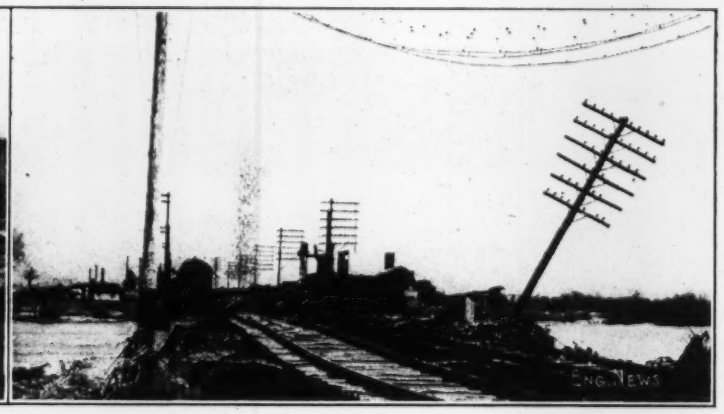
TRACK CONDITION SOUTH OF NEW RIVER BRIDGE

DESTRUCTION OF ROADBED NEAR MIAMISBURG

ROADBED WASHOUT AT CARLISLE

CROSSING OF OHIO ELECTRIC RY. OVER C. H. & D., BETWEEN TRENTON AND MIDDLETOWN

(Both abutments underwashed and broken; C. H. & D. temporary track run through on S-shaped alignment after hoisting wrecked span out of the way.)

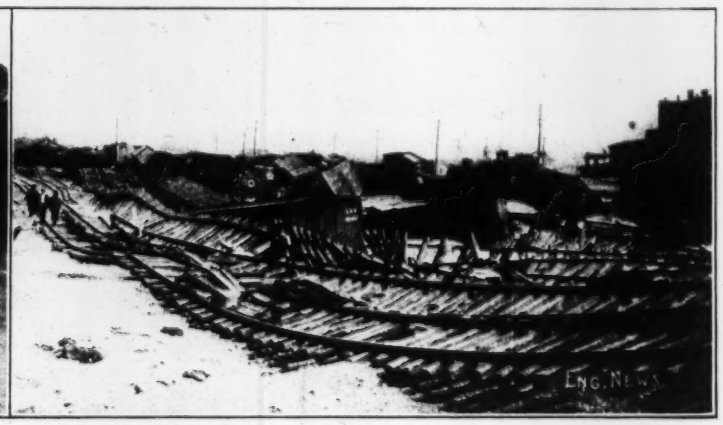


NEW RIVER BRIDGE OVER BIG MIAMI NORTH OF HAMILTON, INTACT

(Plate-girder spans, about 10 ft. depth of web. Water flowed 2-3 ft. over the tops of the girders. The L. H. & I. Ry. bridge, 2 mi. south, went out by undermining of the piers.)

AT HAMILTON PASSENGER STATION, A FEW HOURS AFTER THE CREST OF THE FLOOD, LOOKING WEST

(The water flowed south through the city and returned southwestward to the river, which passes around Hamilton with a large westerly bend.)



SOUTH HAMILTON YARD, AFTER THE FLOOD

(Roadbed under tracks scoured out some 15 ft.)

FLOOD DAMAGE ON THE LINE OF THE CINCINNATI, HAMILTON & DAYTON R.R. (B. & O. SYSTEM)

Marietta was carried away, as were also a number of small stations on the division. A temporary bridge will be put in operation until the steel bridge can be replaced; and owing to the fact that the county bridges at Marietta were lost, the railroad has arranged to lay flooring and permit the public to use the structure.

In the Ohio River District, tracks were badly washed, stations carried away and other railroad facilities destroyed. The Ohio River reached a stage of 50 ft. 9 in. at Parkersburg, the highest on record. No bridges were lost in the Ohio River District nor was there any loss of freight on the division, all shipments having been taken to high ground before the flood became serious.

The main line of the Baltimore & Ohio Southwestern, between the Ohio and Wabash Rivers, was badly damaged. Two spans of the bridge across the Miami River at Lawrenceburg were carried away, breaking the main line between Cincinnati and St. Louis. Similar damage occurred at Vallonia, over the west fork of the White River. Temporary structures will be used for train operation until new bridges, which have been contracted for, can be put into place.

The most serious damage on the Baltimore & Ohio System was sustained on the Cincinnati, Hamilton & Dayton. Sections of the line were almost entirely destroyed. At Hamilton, Ohio, the yards were washed out, rails twisted and broken by the water, equipment destroyed and general havoc wrought. The bridge at Hamilton over the Big Miami River was lost and it is estimated that the damage to Cincinnati, Hamilton & Dayton property totaled $500,000.

The Dayton terminals were flooded and the railroad yards were undermined and washed away. The damage to the C., H & D. terminals at Dayton will probably be about $250,000. On the Indianapolis division the losses will approximate $150,000 from the loss of bridges at Brownsville and Morristown, Ind., and washouts.

BIG FOUR SYSTEM

(From J. Q. Van Winkle, General Manager.)

The damage to the lines of the C., C., C. & St. L. Ry., Peoria & Eastern Ry. and Cincinnati Northern R.R. was heaviest in the territory between Columbus, Ohio, and Indianapolis, Ind. Within the above territory, about 40 permanent bridges across the Miami, Olentangy, Mad, White Water, White and Blue Rivers and their tributaries were washed out and either totally or partially destroyed. Besides these bridges, there were numerous washouts of embankment and tracks aggregating 25 to 30 miles in length. The damage to these lines west of Indianapolis was confined to three crossings of the Wabash River at Terre Haute, Ind., and St. Francisville and Mt. Carmel, Ill. At Terre Haute and St. Francisville, the embankment approach at the west end of the bridge was washed out in each case and at Mt. Carmel, some of the pile trestle approaches and trestles across the bottom lands east of the river were washed out, but at none of these three places was the river bridge damaged.

Of eight crossings of the Miami River by these lines, five were washed out. Of four crossings of Mad River, two were washed out, and of three crossings of White Water River, all were washed out.

Of the 40 permanent bridges damaged, 19 will require replacement with steel superstructures, aggregating about 7000 tons. The remainder will be repaired or replaced with concrete structures.

The methods of restoring traffic were confined to those which promised the quickest results, regardless of expense. In cases of washed out embankments where the drop below the grade line did not exceed about 10 ft., the temporary track was laid on the ground and connected with the permanent grade by temporary steep grades and the tracks raised on embankment as soon as possible after the traffic was restored. In cases where there was water to be crossed, or the holes were too deep for the above method, pile trestles were driven. The total length of pile trestle thus driven and in progress at the time of this writing, will be about 5000 ft., much of this requiring piles from 65 ft. to 80 ft. long. Of course, the material required for these trestles far exceeded the amount of emergency material carried in stock, and timber and piling were obtained in the markets wherever available. In one case, a track was laid for four miles on an abandoned grade from Franklin to Miamisburg, Ohio, the right-of-way being obtained within three days from the owners to whom it had reverted when abandoned for the new cut-off line about three years ago.

The largest single structure destroyed was the White Water River bridge west of Cincinnati, consisting of two double-track 165-ft. through-truss spans, built in 1906. The masonry and foundations, however, were much older than the superstructure. The pier and one abutment were washed out and the spans landed fully 200 ft. down stream. A double-track girder bridge across the Miami River in the same vicinity was washed out and seven spans out of eight lost. Only one pier and one abutment remained standing.

On the Miami River crossing north of Middletown, Ohio, consisting of eight spans double-track deck girders, four spans were lost and three piers washed out and one pier tipped over. On another crossing of the Miami River south of Miamisburg, Ohio, consisting of seven double-track 100-ft. plate girder spans, four piers and one abutment were washed out or tipped over so that they must be taken down and one girder span was lost. Both these bridges were built in 1906 and had concrete piers with foundations in gravel extending six to eight feet below the bed of stream.

In one or two cases, the superstructure was swept off the masonry by the force of drift lodged against it, and the masonry was uninjured; but in most cases the damage resulted from scouring of foundations or the destruction of defective, old stone masonry. In at least two cases, the masonry, presumably on rock foundation, was destroyed. In a number of cases, the breaking or overtopping of adjacent embankments by the water saved the bridge from destruction.

The lesson to be learned from the results of the flood points toward deeper foundations and more ample waterway. The widespread character of the devastation comprehending Railroad, County and City bridges, indicates that no one particular structure or one method is at fault, but simply that engineers must take into consideration weather conditions not heretofore considered possible.

TOLEDO & OHIO CENTRAL AND ZANESVILLE & WESTERN RAILWAYS

(From H. E. Speaks, Gen. Superintendent.)

About 10 a.m., March 25, the Scioto and Olentangy Rivers at Columbus overflowed the levees and caused them to break at five points within a distance of two miles, the breaks in the levee being approximately 800 ft., 600 ft. 120 ft., 2000 ft. and 250 ft. This turned the water into the freight yards and stations and the passenger station located on West Broad Street, the water in the passenger station and freight station being 4 ft. deep, overturning 19 freight cars in the freight-house yard and covering the tracks with mud and gravel to a depth of from 2 to 4 feet. In all 88 freight cars, 11 passenger cars and 2 engines were derailed. Approximately 50 freight cars were overturned and piled up in a tangled mass over the main tracks and yard tracks. There was about 15 ft. of water over the yard and it was impossible to get into the yard to begin making repairs until the afternoon of March 30. Between Broad Street Station and West Columbus, both main tracks were washed off the fill for a distance of three-quarters of a mile.

The most serious damage to the T. & O. C. Railway tracks and structures occurred in Columbus but the tracks were damaged at many points on all divisions. No steel bridges were lost, but the masonry was damaged at three important bridges, not so seriously, however, as to delay traffic for any considerable length of time. Trestle bridges suffered considerable damage at all points.

The Zanesville & Western tracks were very seriously washed between Thurston and Zanesville. About 1800 ft. of track in the neighborhood of Mt. Perry was swept off the fill into the creek. The passenger station at Zanesville stood in 12 feet of water and the walls were so damaged that the building was condemned by municipal authorities.

As soon as the waters subsided repair gangs were started at various points on the line. All the regular forces and all extra laborers that could be employed were put to work. We had in all about 1100 men at work. The repair work at Columbus was rendered especially difficult on account of the fact that the bridges connecting the East and West sides were all damaged but one. Military and police took charge of the situation and it was very difficult to get men and supplies through the lines. Men once employed were obliged to stay on railroad property and the Railroad Company was obliged to provide food and shelter for all men employed. Ballast and filling material was shipped in from distant points, a large amount being hauled as far as 200 miles, until such time as it was possible to put the steam shovels at work in the neighborhood of Columbus. The effects will be felt for the next two years and the maintenance-of-way expenses will necessarily be above normal.

❖

Sleeping Cars on an Electric Railway System are still sufficiently out of the ordinary to attract attention. The Illinois Traction Co., an electric traction system, doing steam railroad work, under a steam railroad charter, has carried 40,000 passengers, during the past year, in its electric sleeping cars and is ordering new cars of this type to meet the demands of an increased traffic.

Damage to Structures in the Indianapolis Flood

By DeWitt V. Moore*

In the writer's article in last week's issue of ENGINEERING NEWS, a general description was given of the conditions during the week of the Indianapolis flood and a brief statement of the damage. The present article is a more complete account with especial reference to the damage to structures. In connection with the points of principal damage an approximate estimate is given but it should be understood that this has been made without definite surveys and is only a rough approximation.

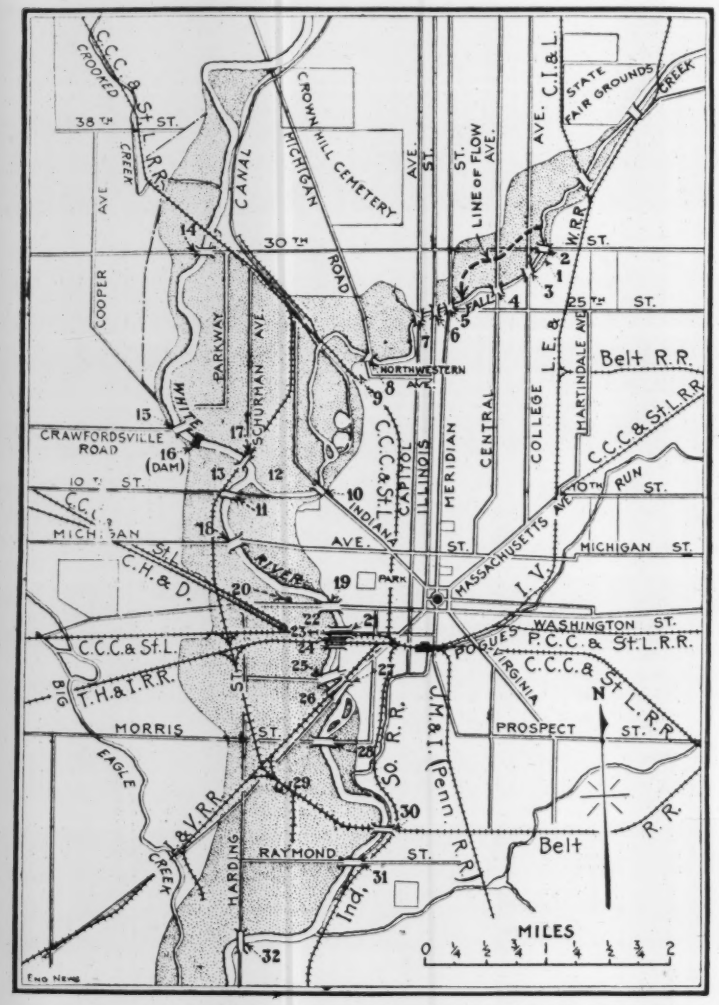


FIG. 1. MAP OF INDIANAPOLIS, SHOWING FLOODED DISTRICT SHADED

[Reprinted from "Engineering News," Apr. 17, 1913, p. 804]

RAINFALL—The report of the Weather Bureau, as previously given, only included the City of Indianapolis, as the flood conditions prevented complete reports from other stations. As a matter of record, explaining the reasons for the abnormal conditions of Indianapolis, it is necessary to give the complete information which is now available from the other stations within the drainage area of White River.

According to the Bureau the rainfall in Indiana for the month of March exceeded all records of the Bureau. The records show 8.91 in. for the month, which exceeds the previous record of April, 1893, by 0.45 in. The rainfall at Indianapolis of 6.01 in., as given in detail in the previous article, was the greatest recorded in the last 42 years, except in July, 1872, when 6.43 in. fell in four days. It is presumed, however, that this latter fall was local in character.

The greatest previous recorded flood in Indianapolis occurred in the latter part of March, 1904, and resulted in large damage, especially to the bridges over Fall Creek and White River. As a result of this previous flood there was much agitation for better bridges and stream improvement which will be mentioned more in detail later in this article. In this flood of 1904 rain began to fall on Mar. 24 and continued for two days with a rainfall of 5.44 in. extending in a general way over the drainage area of White River. The average rainfall over the drainage area of the west fork of White River, which is the "Indianapolis White River," was, in this 1904 flood, as reported from seven stations, 4.97 in. These same seven stations reported for the recent flood an average of 7.81 in., an increase of 2.84 in. The average rainfall over the east fork of White River in 1904 was 4.19 in. and in the recent flood, 8.41 in.

In 1904 the highest point reached by the flood, according to the Indianapolis Weather Bureau gage, was 21.3 ft. This gage was destroyed by the recent flood but the height of the water has been determined by the Weather Bureau as 25.7, an increase of 4.4 ft. At Anderson, Ind., the highest record was 22.1 ft. or 3.3 higher than in 1904. At Shoals, Ind., on the east fork of White River, the gage recorded 22.2 or 8.1 ft. higher than in 1904.

This exceptional rainfall, in connection with the fact that the ground was saturated by previous rains, gave a rapid run-off and it is estimated that the recent flood was 50% greater on the area of the west fork of White River.

FLOOD DAMAGE

In the following detail description, reference should be had to the map (Fig. 1) and to the figures marked thereon. The damage in Sutherland Ave. (1) is shown in part by photograph (Fig. 6). Sutherland Ave. extends along the east bank of Fall Creek between College Ave. and 30th St. and the main track of the Union Traction Co. was located therein. Almost this entire length of street, including track, was washed out and disappeared in the flood. In the background of the view (Fig. 6) can be seen a part of the east span of the 30th St. bridge (2) which is undamaged. About 900 ft. of track was carried down and the main damage to the street was in two sections, one of 300 ft. and one of 600 ft., with a washout of 40 to 50 ft. in width. The bank at this point is approximately 25 ft. in height. The entire length of the street between College and 30th, approximately 1300 ft., was damaged with the main washout as just described. The southeast wing wall of the College Ave. bridge, about 50 ft. long by 8 ft. high, formed a part of this damage. Opposite this point on the north side of the stream there is a small washout of about 150 ft. long by 20 ft. in width. It is estimated that the damage at this point will amount to $50,000 or $60,000 so far as the municipality is concerned and $3000 to $5000 for the Union Traction Co.

As an illustration of how far ranging the flood dam-

*Consulting Engineer, Merchants' Bank Bldg., Indianapolis, Ind.

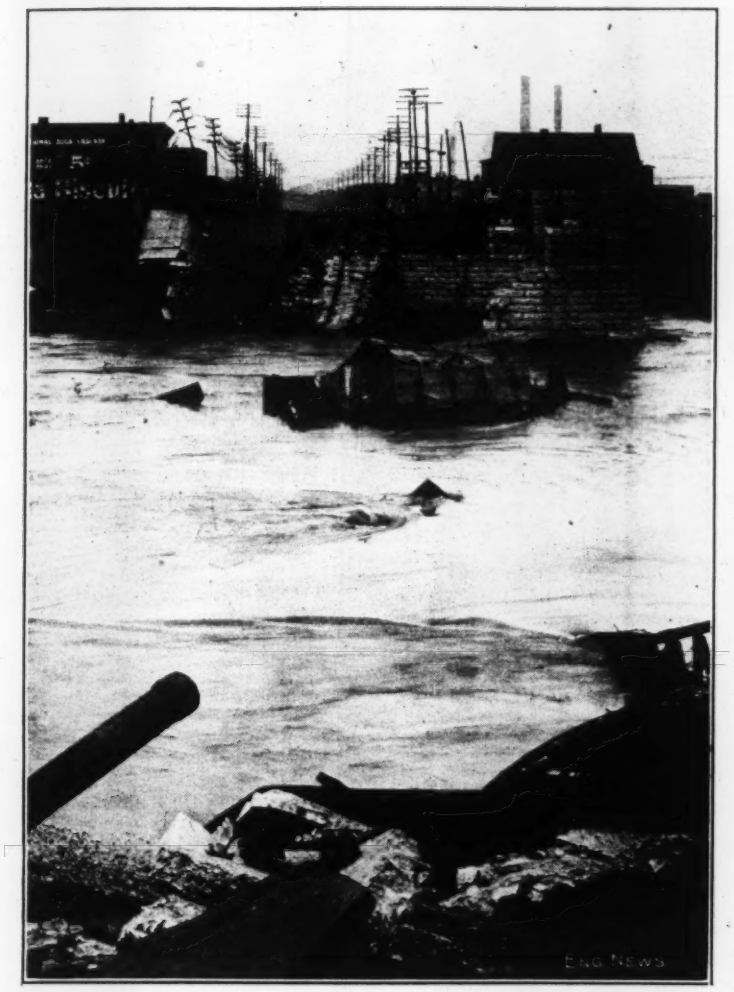


FIG. 2. RUINS OF WASHINGTON ST. BRIDGE
[No. 19 on Fig. 1.]

age extends and how hard it is to estimate the cost, attention is called to the condition in which the Union Traction Co. finds itself at this time. For a long time the property owners have been seriously objecting to the use of Sutherland Ave. by the Union Traction Co. The Board of Public Works, in meeting this question, proposed that the traction company enter the city by way of Martindale Ave., a north and south street east of the Lake Erie & Western and Monon Rys., thence by way of Massachusetts Ave, passing through the undergrade crossing of these railroad tracks. This would remove the traction line from College Ave., one of the better residence streets of the city. Objections have been made to the Martindale Ave. line on account of the Belt R.R. crossing and the fact that there is not sufficient head room beneath the undergrade crossing. The traction company is, at present, entering by way of a temporary track in order to reach College Ave. The flood damage at this point will no doubt result in a settlement of this controversy. The cost to the traction company will therefore be greatly increased if the new route is taken.

The College Ave. bridge (3) suffered but little damage, except in connection with the washout just mentioned, which destroyed the southeast wing wall. The Central Ave. bridge (4) suffered no damage.

Between Central Ave. and Capitol Ave. (7) the boulevard and permanent roadway on the south bank with the decided curve joining the south abutment of the Meridian St. bridge (5) projected out into the stream and obstructed the flow through the south span. Opposite this point the flood water, as previously mentioned, broke through the bank and reëntered the creek. These conditions resulted in the undermining of the upstream end of the foundations and a setttlement of about 6 ft. in the piers of the bridge. That portion of the boulevard extending into the stream was seriously damaged for a distance of 230 ft., including 200 f'. of wall. It is estimated that the cost of temporary work, removal of the old bridge and reconstruction will cost the city $150,000 to $200,000 and this amount will be increased if, as a result of this flood, the length of the bridge is increased. Reference should be had to the general view of the collapse of this bridge (Fig. 2 of previous article) and the detail view of the damage to the bridge (Fig. 4) and the general view of the washout in boulevard (Fig. 3) in this issue. This bridge, which was constructed in 1900 consisted of three spans of about 75 ft. each, with a rise of about 10 or 12 ft. The piers were 10 ft. in width with the foundation approximately 15 ft. below low water. As before mentioned there is no doubt the foundations of the piers were effected by the dredging of the creek to obtain gravel for the constructing of the boulevards, but just how much wash occurred has not been determined by the writer. The bridge was of concrete with stone facing. The thickness of concrete at the crown of the side spans was 15 in. and of the center

FIG. 3. WASHOUT OF RETAINING WALL AND EMBANKMENT ALONG BOULEVARD ON FALL CREEK

span 16 in. The reinforcement consisted of 10-in. I-beams of 25 lb. per ft., spaced 3 ft., c. to c. The plans for this bridge* were made under date of Sept. 11, 1899, by the City Engineer and the Illinois St. bridge (6) was constructed from the same plans, the only difference being in minor particulars.

The Illinois St. bridge passed through the flood successfully, no doubt as a result of the angle of crossing. Neither bridge was on piling. The Meridian St. bridge collapsed on a longitudinal line, being practically the upstream half of the bridge. The west half of the bridge appears to have suffered no harm and by the construction of a temporary railing along the line of fracture, this bridge may be placed in service until such time as plans can be prepared and appropriation made for the complete reconstruction. The current swinging again to the north caused a slide in the gravel fill of the boulevard improvement on the north bank of the creek west of the bridge.

In connection with the boulevard work the south bank of Fall Creek is protected by a concrete wall 5 ft. high from Central Ave. to Capitol Ave. and on the north bank from Central Ave. to Illinois St. These walls were built on piling and were injured very little, except as just mentioned. Some of the older part of the wall was built with separate facing of concrete which has peeled off in a good many cases but this cannot be attributed to the flood.

The Capitol Ave. bridge (7) was not damaged, but there has been considerable criticism on account of the insufficient waterway and the damming of the stream. West of Capitol Ave. the water spread out over the low ground until it was approximately 3000 ft. in width and extended to the west until it met the flood water from White River. This portion of the city was practically all flooded, with a width in all directions of approximately 1½ miles. The Northwestern Ave. bridge (8) was not damaged to any great extent.

The Indianapolis Gas Co. (9) located just west of this bridge and on the south side of the creek, was flooded to the extent of interruption of service only. During this period of interruption gas was supplied through the mains of the Indianapolis Gas Co. by the Citizens' Gas Co., which was so located in the southeast part of the city that there was no interruption in their operation. As a result there was no shutting off of the gas supply, although the quality of gas furnished was not equal to the standard ordinarily available. This statement applies generally, although there were certain cases where, on account of local damage to mains, the gas supply was cut off.

Between this gas plant and the Indiana Ave. bridge (10), a little over a mile directly south, is located the filtration plant of the Indianapolis Water Co. This plant is on both sides of the creek from about 15th to 21st Sts. The water is brought from White River by means of a canal, from a point about nine miles north and then by gravity conduits to the main pumping station (Riverside) (12) and to the secondary station at West Washington St. and White River. On account of the flooded condition and the breaks in the bank of the canal and Fall Creek, the filtration plant was out of the question. Emergency intakes are provided in Fall Creek and White River but these were of no value on account of the breaking in the levees and the flooding of the Riverside Pumping Station, which it will be noted, is directly at the junction of the creek with the river.

At the time of the flood of 1904 the water company was out of commission and it was apparent that better protective work in the way of levees was absolutely necessary in order to avoid a repetition. It is interesting to note that on Mar. 26, 1904, the water company issued a bulletin to its patrons, stating that on account of the breaking of the levees the water had flooded its station to a depth of 3 ft., putting out all fires of boilers. On the same day the water company wrote the Board of Public Works to the same effect, but stating the conditions somewhat more in detail. It is evident that this warning was not heeded as the recent flood resulted in the same conditions but to a greater extent. Indianapolis was fortunate in having no fire of any consequence during this interruption of the water supply, which lasted from 10:30 p.m. Tuesday, till 7 a.m. Friday, Mar. 28.

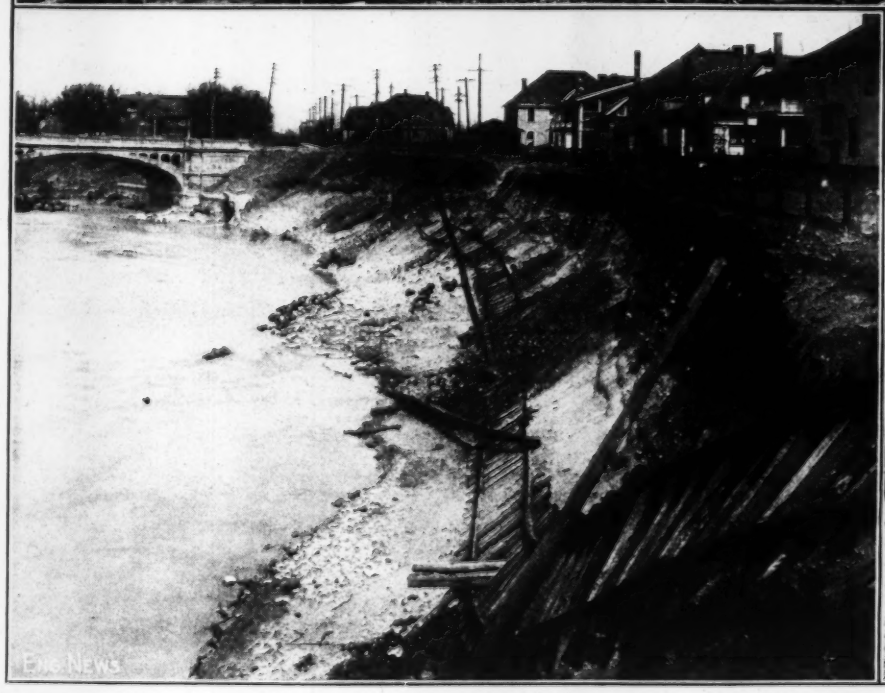
Between the Indiana Ave. bridge (10) and the West 10th St. bridge (11), there was large damage. On the south side of the creek, 10th St., which is constructed on embankment, was practically entirely washed out for a length of about 3500 ft. In 10th St. was located the high-tension feeder lines of the Indianapolis Traction Terminal Co., which were destroyed for a length of about 4000 ft. This condition contributed to the suspension of street car traffic and had a serious effect on the resumption thereof. On the north side of the creek 2500 ft. of levee, protecting the Riverside Pumping Station (12) was badly damaged, there being numerous breaks. It is estimated that the damage at this point will aggregate $50,000 to $75,000, which should include some repairs to the 10th St. bridge (11), which is damaged on the northwest wing of the west abutment. In this latter case it would seem that the abutment would require reconstructing as there is a crack 6 in. wide at the top and an apparent sliding at the bottom of 2 in. The bridge is apparently in good condition outside of this damage. While the actual property loss at the Power Station was not so large, probably not over $5000 to $10,000, still the loss to the community through the interruption of the transportation service, was beyond calculation.

In the northwest corner at the crossing of the Belt R.R. and West 10th St., is located this new power plant of the Indianapolis Traction Terminal Co. (13). As previously mentioned, the water from White River broke through the levee on the south bank directly north of this point and also through a secondary levee located about half way. These breaks were approximately 1000 ft. in length. This water, in connection with the flood water of Fall Creek, washed out the entire single-track embankment of the Belt R.R. from 10th St. to White River, approximately 1100 ft., and flooded the power house. No damage resulted to the power plant except in the flooding of the machinery and the washing out of the coal supply, siding, etc.

The West 30th St. bridge over White River (14) and the Emerichsville bridge (15) suffered no damage as has been previously reported. Riverside Dam* (16) was previously in bad condition so far as abutments and washouts, but was not further damaged. The Belt R.R. bridge (17) is in good condition, no doubt as a result of the breaking of the levee on the south bank west of the bridge as before mentioned.

*"Engineering News," Apr. 11, 191, p. 258.

*"Engineering News," Nov. 7, 1912, p. 852.



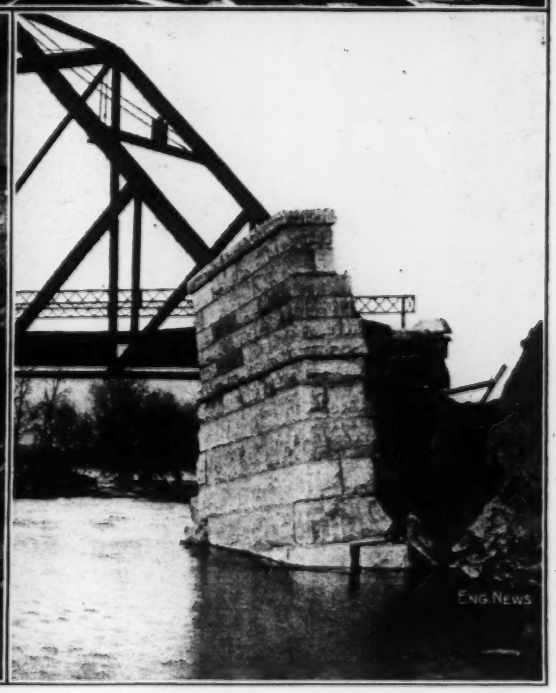


Fig. 4. Wreck of Meridian St. Bridge.
Fig. 5. Railway Embankment at South of City.
Fig. 6. Bank Cutting on Fall Creek near College Ave. Bridge.
Fig. 7. Displaced Abutment, Harding Ave. Bridge.

FIGS. 4 TO 7. VARIOUS DAMAGE DONE BY FLOOD AT INDIANAPOLIS

From 36th St. to 30th St. on the west side of White River and from 30th St. south to the Emerichsville bridge on both sides of the river lies Riverside Park, the pride of Indianapolis. North of 30th St. on the west side is the permanently improved portion of the Park, including the Shelterhouse, Zoo, Golf Links, etc. Serious damage was here experienced. At the east approach of the 30th St. bridge is the Amusement Park or Midway. All of these attractions were under water, and there is no means of knowing how much damage resulted. From 30th St. south along the east bank and some little distance back from the river was located the most beautiful section of the boulevard system. This boulevard was entirely on embankment with improved roadway the entire length of about 7000 ft. with lights on both sides at intervals of approximately 50 ft. Four sections of this embankment were entirely washed out; one of 600 ft.; one of 900 ft. and two of 40 ft. each. The improved roadway was practically all destroyed. Between this boulevard and the river a large number of young trees, recently set out, were uprooted. It is estimated that the damage to the Park in connection with this boulevard construction and the Park Improvements, will amount to from $75,000 to $100,000. This damage is not only of many dollars but of serious inconvenience in access to the park and as a pleasure drive that will be greatly missed the coming season.

The Michigan St. bridge (18) suffered no damage of any consequence. It will be noted that below Michigan St. the entire territory from White River to a line west of the Belt R.R. was entirely under water, the width ranging from a mile to a mile and one-half. It was in this territory that the personal suffering was experienced to the greatest extent. It is almost impossible to estimate the damage to buildings and property including, as it does, residences destroyed together with mercantile and manufacturing establishments. It has been estimated that there are 3000 homes in this territory which demand rehabilitation and this does not take into account those properties which were entirely destroyed nor the manufacturing plants.

The Washington St. bridge (19) over White River was entirely destroyed as previously reported. A good idea of the failure under present conditions is shown by photograph (Fig. 2). This bridge was constructed in 1905 and consisted of a deck girder with concrete floor and stone abutments, piers and railing. Plans for this bridge cannot be located. Part of the recent developments, as a result of the flood of this year, has been the appropriation by the County Council of $200,000 for the rebuilding of this bridge. There is, however, a hitch at this time in proceeding under this appropriation, inasmuch as the County Council has asked that the Indiana Traction & Terminal Co. pay one-fifth of this amount, inasmuch as they occupy one-fifth of the bridge.

In connection with this reconstruction there has been, for some time, agitation for a new bridge crossing White River at New York St., 1500 ft. to the north and 4000 ft. upstream from the Washington St. bridge. In connection with the apppropriation for Washington St., $150,000 has been appropriated for New York St. It is doubtful is this latter appropriation will be sufficient.

The next bridge across White River is that known as Kingan's (21). This bridge was the old railroad bridge used by the Big Four R.R. for the St. Louis and Chicago Divisions, the P. & E. R.R. and the old I. D. & W. R.R. When the new Big Four bridge (22), constructed just south of the Kingan bridge, was completed all traffic of these railroads was transferred thereto and the old bridge was used simply for switching purposes and as a cattle bridge for Kingan & Company connecting their plants on both banks of the river. This cattle pass was constructed by brackets or cantilever construction on one side of the bridge. This bridge was entirely destroyed.

The Big Four bridge and the new Vandalia bridge suffered but little damage. Just below is the old Vandalia Main Line bridge (24). This bridge was a complete wreck and piling is now being driven to reconstruct the bridge. Both the new Vandalia and the Big Four bridges extend beyond the river to form an overhead crossing with Perry Ave. No damage existed at this crossing but Perry Ave. was badly washed out and damaged for a distance of 1500 ft.

Immediately south of the new Vandalia bridge and on the west bank of the river a large section of levee was removed by the flood. The Oliver Ave. bridge (25) suffered no damage but the levee on the west side of the river, down to and including a washout of 30 ft. back of the west abutment of the Kentucky Ave. bridge, was entirely washed out and it was through this break that a large part of West Indianapolis was first submerged.

The old I. & V. R.R. bridge, now the Vincennes Division of the Vandalia (26) was practically destroyed, two spans being down and the west span being washed down the river some distance. Next down stream the Kentucky Ave. bridge (27) which, as just mentioned, suffered a damage by the washout of the west abutment.

The Morris St. bridge (28) was not damaged but on the west bank of the river immediately upstream 250 ft. of levee was washed out and there was also some damage to both approaches on the upstream side.

It is estimated that the damage to bridges and levees in this section, from Washington St. to Morris St., a distance of about one mile and located the nearest to the business district of the city and including a crossing of all west and east bound tracks, was damaged, $300,000 to the city and $150,000 to $200,000 to the railroads and Kingans.

The Raymond St. bridge at the City Limits, south, was washed out; 500 ft. of the west approach; 700 ft. of levee on the west bank and a loss of the west span and abutment.

The Harding St. bridge south of the stock yards suffered no damage except the washing out of the north abutment. It is estimated that the damage to these two bridges amounts to from $40,000 to $50,000 (Fig. 7).

Passing from the actual damage along the streams, the damage to the railroad lines within the liimts of the submerged area should be noted.

The Big Four R.R., St. Louis Division and the Main Line of the Vandalia R.R. cross the Belt R.R. on the west side of this flooded district. In both cases the roads are connected by double wyes. All the railroads suffered a large amount of damage at these points (Fig. 5). At the Big Four crossing the Belt R.R. had 1000 ft. of washout of three-track embankment and the Big Four, 450 ft. of two-track embankment on west wye and 350 ft. of single track on east wye. These embankments would probably average 12 or 15 ft. in height. Practically the same condition existed at the crossing of the

Vandalia, the Belt, however, losing only 30 ft. of the three-track embankment, while the Vandalia lost approximately 900 ft. of three-track embankment. The west wye, a two-track embankment, was entirely washed out for a length of 900 ft. These embankments were approximately the same height as just mentioned. The Belt R.R. again suffered a 500-ft. washout at Oliver Ave. about 1500 ft. south of the Vandalia, the height of embankment, however, being much less. The Belt R.R. again suffered a 1500-ft. washout of a four-track embankment 15 ft. in height beginning at the stock yards and extending southeasterly towards the crossing of White River. The railroads experienced a large damage to equipment, the extent of which, however, is not obtainable.

The Illinois Central R.R. tracks are located on the east bank of White River from a point 1500 ft. north of the Belt to a point a mile south. Along the line of the Illinois Central, just north and south of the Belt, the main line was washed out for about one-half mile, but as the construction was low grade, the damage was not heavy. Twelve hundred lineal feet of levee between the railroad and the river was entirely washed away and approximately one-half of the heavy embankment of the Belt R.R. connection was entirely destroyed. On the old I. & V. Railroad at a point one-half way between the river crossing and the Belt R.R., 800 ft. of single track embankment was entirely washed out.

It is estimated that the cost of construction of these main line railroads in connection with sidings, wyes, etc., will cost $150,000 or more and this estimate does not include the loss of equipment. The Belt R.R. reports a loss of $100,000.

The foregoing description is given considerably in detail for the purpose of placing on record definite information. In addition to the damage mentioned there were many miles of streets and sidewalks which were either destroyed or badly damaged and regarding which, information will not be available for a long time. However, roughly estimating this latter damage in connection with estimates above, it is probable that the cost to the City will run from $1,250,000 to $1,500,000.

It is estimated that the loss to the property owners, house-holders and industries throughout the flooded section will approximate $2,000,000.

It is estimated that the loss to the railroads and public utilities within the city limits will amount to $500,000 to $1,000,000.

No consideration has been given in this estimate to any damage in Marion County outside of the City of Indianapolis. The damage, therefore, as just estimated, will range from $3,750,000 to $4,500,000.

Repair and Improvement Work

Immediately following the flood of 1904 there was much agitation with respect to the encroachments on the streams by individual property owners and this agitation led to the passing of an ordinance prohibiting such practice and the instruction that a survey be made and definite bank lines established. The agitation, however, subsided and, probably due to the change of administration, the making of this survey was overlooked. In the course of a short time the encroachment on the streams proceeded as before. Part of this trouble was a result of the question as to whether or not the west fork of White River is a navigable stream. In 1787 the river was declared to be navigable but 37 years ago the Indiana Supreme Court handed down a decision adverse to this law. The result was that the property lines extended to the center of the stream. This question is now again receiving attention and to a greater extent than before. The City Engineering Department is making a comprehensive survey of all the streams within the city limits and as a result bank lines are to be established. This will, no doubt, result in certain cases in the condemnation of much property. The city officials have evidenced a disposition to not trifle any more with the situation but instead to make a careful survey and then enforce the requirements. It is stated that the law passed by the recent assembly prohibiting the filling of streams beyond a line fixed by the Park Commission is a source of relief, without regard to the question of the navigability of the stream.

Immediately after the flood the City Council appropriated $50,000 for emmergency work and afterwards increased this amount by bond issue to $150,000. This money is to be expended for the purpose of repair of levees and construction of temporary bridges and repairs, without regard for the ultimate improvement of the streams.

The General Citizens Committee received voluntary subscriptions closely approximating $100,000. A second form of relief for the flood sufferers was obtained by the voluntary subscription of three thousand persons contributing $100 each for the refurnishing of three thousand homes, or an ultimate amount of $300,000. The city, therefore, is expending $500,000 for immediate relief.

Annual Convention of the National Drainage Congress

The third annual meeting was held at the Planters Hotel, St. Louis, Mo., on Apr. 10 to 12, with an attendance of about 300 from more than 30 states. Addresses of welcome were made by Mr. Lazarus (President of the City Council) on behalf of the city, and Governor Major, on behalf of the state. The latter referred to the establishment of the State Reclamation Commission, which (in conjunction with the State Waterway Commission) will investigate the reclamation of some 4,000,000 acres of swamp-lands and low-lands subject to floods.

The purposes of the Congress are two-fold: (1) The reclamation of swamp and wet lands by drainage; (2) the prevention of floods. It was noticeable that a large number of those in attendance showed more active interest in papers dealing with specific and "practical" subjects than in those relating to general policy. This was indicated by the discussion which followed the papers on "Tile Drainage," "Excavating Machinery" and "Road Improvement."

The proceedings occupied seven sessions. On the afternoon of the last day there was an excursion by special train to the East Side Levee and Sanitary District. This district includes the city of East St. Louis, Ill., and the surrounding bottom lands, and it is being protected against flood by a long line of high levees, with an outlet or diversion channel for the waters of Cahokia Creek. In addition, a large area of land along the river is being

reclaimed by filling in sand pumped from the river by an electrically operated hydraulic dredge. Mr. Edmund T. Perkins, Consulting Engineer, Chicago, was elected President, and Sir William Willcocks, the eminent British irrigation engineer, was elected Honorary Vice-President. The next meeting will be held at Savannah, Ga., in 1914.

National Administration of Public Works

Two systems for the control of rivers by the Federal Government were advocated at this meeting: (1) By a special commission, as provided in the Newlands bill; (2) by a government "Public Works Department," the head of which (or Secretary of Public Works) would be a member of the Cabinet. This latter plan was suggested in a paper by Isham Randolph (Chicago), who proposed that all the constructive engineering work of the government should be in the hands of this department, leaving to the U. S. Corps of Engineers (under the War Department) all works for military purposes. A resolution was adopted strongly recommending this latter plan, and recommending that it should be put into effect as soon as possible. The matter has already been submitted to the President, and steps will be taken to urge the matter upon him and upon Congress.

The Mississippi River

A good deal of attention was given to the control of the Mississippi River, and to the prevention of floods. Both Isham Randolph and M. O. Leighton, of the U. S. Geological Survey, approved of the reservoir system for the Ohio, but pointed out that in many river basins there are no reservoir sites available.

The levee system as applied to the Mississippi River received strong commendation. The address of Col. C. McD. Townsend, U. S. A., President of the Mississippi River Commission, was printed in our last issue. Mr. Fox, Secretary of the Mississippi River Levee Association, declared that as this river is the outlet of waters from many states, it is not right that the people living along it should have to protect themselves from floods. Such protection should be afforded by the general government. So far, $60,000,000 has been expended by the people of the flood areas, and $27,000,000 by the Federal government; the latter expenditure has been chiefly for dredging and bank revetment.

He stated that the levee system of control had been proved sufficient beyond all doubt, but the people of the locality affected had not money enough to complete the system or to make the levees of the size and strength requisite for safety. It is estimated that $58,000,000 will suffice for this work, and he approved the Humphreys-Ransdell bill now before Congress which provides for an annual expenditure of $12,000,000 for five years ($60,000,000); 75% of this is to be for levee work and 25% for bank protection. Mr. Perkins (Chicago) expressed some opposition to this bill, as dealing with only one detail of flood protection work, and he thought this class of individual legislation should give way to a comprehensive control of the river systems by the government.

Mr. Leighton (U. S. Geological Survey) gave an illustrated lecture on the Mississippi basin, showing its varied character, the varied character of engineering works needed for conservation and regulation of its waters, and showing also its great possibilities for agricultural and industrial development if the floods can be controlled and the wet lands drained. Other speakers also dealt with this latter point, showing the enormous area which would thus become available for settlement.

When the resolution was submitted calling for government control of the rivers (as noted above), Mr. Oliver (Cape Girardeau, Mo.) made a motion to include in it an indorsement of the proposed plan for improving the Mississippi River and appropriating funds for completing the levees. This was strongly opposed, not on the ground of opposition to the project in itself, but on the ground that the Drainage Congress should deal with matters of principle and policy, and not weaken its position by seeking to support or encourage individual projects. Furthermore, it was urged that this "pork-barrel" system of promoting appropriations for individual projects is one of the things the Drainage Congress is opposing, since it stands for a system of river regulation on a broad and comprehensive plan, leaving the question of the relative merits of individual projects to the consideration of the men who administer this system. After rather heated discussion and some "impassioned oratory" urging the indorsement of the Mississippi River project as a matter of sentiment, the amendment was rejected by a large majority vote.

Land Reclamation by Drainage

Several papers related to the possibilities of great development by the drainage of wet lands, in both small and large areas. Mr. Morgan (Memphis), in a paper on "The St. Francis Basin," questioned whether the government should assume control of such work, and considered that drainage is already keeping pace with the demand for land. In this basin most of the territory has been organized into drainage districts, while a certain part of the territory cannot be reclaimed profitably until the market value of land is much greater than it is at present. On the other hand, he thought the government could assist very materially in two ways: (1) By supervising the engineering work and working out the hydraulic features, instead of undertaking to promote individual projects; (2) by assisting drainage development by guaranteeing the bonds (under proper regulations) so that a lower rate of interest could be obtained.

Dr. Pratt (State Geologist of North Carolina), presented a paper on "Reclamation of Swamp Lands in North Carolina," and H. M. Cottrell (Rock Island Lines) discussed the opportunities for the investor and the farmer in reclamation projects, laying stress upon this as a means of checking the emigration to Canada.

A paper on "Tile Drainage and Its Relation to Floods," by C. G. Elliott (U. S. Department of Agriculture) received special attention and was followed by a brisk discussion in the shape of questions upon specific points.

A paper on "Excavating Machinery" by Prof. A. B. McDaniel (University of Illinois) described in brief a variety of machines used in excavating canals, ditches and trenches, and covered much the same ground as a paper in our issue of Feb. 23, 1911. He was of the opinion that carelessness is too often evident in construction and repair of the machines, parts being made of insufficient strength until repeated breaks lead to these parts being made a little stronger, a practice which is expensive and unsatisfactory. In regard to trench machines of the chain type it was suggested that they might be so ar-

ranged as to deliver the excavated material behind the machine (as backfilling) instead of along the side of the trench, and in the discussion it was shown that such machines have been built. While the ladder dredge is little used in this country (except for placer mining), a case was mentioned where such a machine had been used in a drainage canal or ditch in Iowa. Reference was made to the lack of complete and reliable information as to the cost of work done by excavating machinery, and greater attention to the keeping and use of cost data was advocated.

The Relation of Drainage to Public Health

This aspect of the subject was dealt with by Dr. Evans (Chicago), who pointed out that one of the most serious effects of a flood is the aftermath of sickness and disease, resulting both in death and in temporary or permanent loss of efficiency. Thus in a flood in the Wabash Valley the flooding of privy vaults caused the pollution of wells, with a resultant epidemic of typhoid. The address dealt more especially, however, with the so called malarial condition of swamp and wet lands; and the enormous aggregate loss of human energy and efficiency due to this. The work of the United States authorities on the Panama Canal and in Cuba shows what can be done, and as far as the disease-spreading work of the mosquito is concerned this could be practically eliminated in a period of five years. As to the industrial value of such work, it would not only open up large areas of land for settlement, but in districts now known as malarial, the value of land would increase as soon as it became known that malaria had been eliminated.

A National Malarial Congress was organized during the meeting by representatives of a number of state and other health and sanitary associations, for the purpose of taking steps to wipe out this cause of disease and inefficiency. It is to hold meetings annually, in connection with those of the drainage congress. Dr. Dowling, of the State Board of Health of Louisiana, was elected President.

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Tile Drainage and Its Relation to Floods*

By C. G. Elliott†

Importance of tile drainage is recognized by eminent foreign agriculturists and rural economists, and its extension has been promoted and substantially fostered by European governments.

England, under the Public Moneys Drainage Act of 1829, appropriated $20,000,000 to be loaned to owners of estates at a low rate of interest for tile draining their lands, the work being performed under government supervision. The fund was exhausted in a few years, and private land improvement companies were authorized to grant loans for the same purpose. France granted similar substantial aid about 1850, and as a result the popularity of the improvement outgrew the government funds in that country also, and was afterward carried on by private enterprise.

Tile drainage was introduced into Belgium and Germany where it produced as happy results as in England and France. These governments actually established factories for the manufacture of tile, and appointed stations for its sale at low rates so as to place them within the reach of practically every tenant and landholder. Experiments conducted by the government at various times convinced even the most skeptical of the great advantages to be derived by underdraining.

The progress of this art, which has everywhere proved so valuable to agriculture, has been somewhat intermittent in the United States, but the results have been most satisfactory. From 1835, when tiles were first laid by John Johnston in the refractory clay soils of his farm near Lake Geneva, N. Y., the movement has been passing westward through the level lands of the great corn belt, and is now extending southward.

Drainage and Run-off

The assertion has been made that underdrainage will make land more susceptible to drought. The prediction has been made that if the surplus water were withdrawn by underdrains, the soil would become too dry for the support of crops during seasons of light rainfall. This has been shown to be a fallacy, particularly in clay and other retentive soils. The writer gathered data from various parts of the country upon this point during the abnormally dry season of 1901, and learned that the crops on well drained land better maintained their freshness and made a greater yield than those upon adjoining similar land which had not been drained.

When tile drainage began to be extensively practiced in England, mill owners became alarmed and asserted that draining the land would dry up the streams and ruin their water power. Careful measurements of the run-off from a certain drained tract were made under the direction of J. Bailey Denton, the eminent drainage engineer, for a period of two years, and the results were given by him in a paper read before the Institution of Civil Engineers in 1877. The deductions were that the annual discharge from the drained area was in no instance decreased by the method of draining, but rather slightly increased. This was explained as being due to the decreased amount of evaporation from the drained land as compared with land which carried water upon its surface. The paper became the subject of discussion by members of the society, who became convinced that tile drainage did not materially change the volume of run-off, but that it distributed the flow over a longer period. The question appears to have been settled to the satisfaction of the English engineers and has never provoked discussion since that time.

With reference to the opposite phase of the question, the opinion that underdrainage increases the flow from outlying areas into the arterial streams, prevails to some extent. This is based upon the theory that the removal of water in sufficient quantities to make land arable will necessarily increase the volume of flow in a unit of time. The writer, who is acquainted with many of the level tile-drained areas of Illinois and Indiana, and with the streams which receive their waters, dissents from this view. No measurements of flow before and after the drains were installed have been made. Any evidence upon the matter is derived from personal observation and the memory of those who have been closely associated with the lands and their streams. The area lying at the head of the Big Vermilion River in Illinois may be taken as an example. These lands have been changed from wild prairie into cultivated and well improved farms, and in order to bring them into a high state of cultivation nearly the entire area has been tile drained. As nearly as can be learned, the floods of the river are not as great as they were in the early days when the land was native prairie, through which flowed the sluggish drains provided by nature. Owners of bottom-land contend that they suffer no more from high water than they did 20 years ago. The writer distinctly remembers certain shallow sloughs and watercourses, which became boating streams during March and June floods under original natural conditions, but which are now cultivated fields, the drainage being carried underground by a few tile drains of moderate size.

The action of tile drains upon the land is quite different from that of the open ditch, both with respect to the soil itself and the flow from it. The former remove the surplus water uniformly from the several portions of the field down to the horizon at which the drains are laid. Under such conditions the soil becomes permeable and is placed in a condition to receive the rain as a reservoir would receive it. Before the entire soil becomes saturated the water begins to flow from the drains and continues to do so until the surplus is removed from the several zones of depth. The volume is that distributed over a considerable time instead of accumulating upon the surface and moving off in a flood volume, as is the case where there is no underdrainage. Where tiles have been substituted for an open-ditch system, it has been noted that the outfall ditch never carries the volume of water per unit of time that it did when the open ditch system was in operation.

The use of tile drains is not limited to level lands, but they are equally efficient on wet lands which have abundant slope, where the soil is a stiff clay. They not only affect

*Abstract of a paper read before the National Drainage Congress, at St. Louis, Mo., April 10, 12.

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the physical condition of the subsoil, but effectually prevent the rapid flow of water over the surface and into the near-by streams. Drainage results in conserving the soil water as well as in removing the surplus water.

The terracing of hillsides is another method of checking the rapid discharge of rainfall down the slopes, and in a measure accomplishes for the hills what drain tiles do for the level lands. Tile drainage of wet lands, terracing of hills and slopes, together with the intelligent management and cultivation of lands, are practical and valuable methods of lessening the severity of stream floods and the overflow of valuable creek and river bottom lands.

The scope of the work in underdrainage is widening each year. Waste lands are being eliminated from farms, to the great advantage of their owners and to the community in which they are located. Instead of being limited to small fields, as was once the case, large areas are included in systems which involve the use of tiles as large as 36 in. diameter. The quality of tile is being investigated, trenching machines are used to diminish the cost of ditching, and factories for the manufacture of tile are kept in constant operation.

It should be understood, however, that there are limitations to the use of tile drains. They require the preparation of adequate outlets, without which they cannot be used successfully. They should not be used in places where large open canals are required to carry the water.

The depth of drains is limited by the character of the soil, and the size by the amount of rainfall, the physical structure and slope of the land, and the grade upon which they may be laid. In some cases silt wells, surface inlets and automatic gates are required. In some soils it is not practicable to lay drain tile without costly and careful preparation of the bottom of the trench.

Thousands of miles of drain tile have been laid without previous plans or surveys, but the losses due to such careless work only prove that the best work is none too good and is worth its additional cost.

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Flood Prevention, and a Government Department of Public Works*

By Isham Randolph†

The people of the United States are paying a tribute of millions of dollars to the voracity of floods. We now demand that Congress pay millions for a defense which will shield the people from these floods. What is the remedy? This great government of ours needs a new department, the Cabinet a new portfolio.

Our national defense is cared for by two departments (War and Navy), each headed by a Secretary. State-craft has its portfolio. The vital importance of agriculture is recognized. Our fiscal system is administered by the Secretary of the Treasury. Through the Postmaster General, our President keeps in touch with the needs and the accomplishments of our postal service. An Attorney General represents the strong arm of the law. Labor has a voice in all of the intimate councils. The Secretary of the Interior looks after the nation's wards and is a watchful guardian of what is left of the public domain.

But what of our public works? Who cares for them? The answer is that they are parceled out among the departments, whose chiefs have enough resting upon them to burden the greatest minds in the right discharge of the duties which are legitimately theirs. Public buildings come within the jurisdiction of the Secretary of Treasury. Why? Is a mind trained in the school of finance peculiarly fitted to pass upon the architectural design or structural fitness? Our internal improvements, other than architectural construction and reclamation of arid lands, are entrusted to military engineers. The War Department controls them. Why is this? Does a training in the art of war fit a man to plan and execute the public works of peace? We need a National Department of Public Works, and its executive head should be a member of the President's cabinet. This belief does not minimize my appreciation of the army engineer and the U. S. Corps of Engineers. But West Point does not graduate men enough to supply the engineering needs of a land like ours. The natural consequence is that they seldom work together, one engineer in a place is the rule and one West Point graduate cannot, single handed, do the engineering work of the job to which he is assigned. Hence he must secure the services and surround himself with men educated in the school of experience or in one or other of our great civil engineering schools. The result is apt to be, and too commonly is, that the West Pointer becomes the executive officer; the civilian does the engineering and the officer approves it.

The number and rank of army engineers in service are as follows: One Chief of Engineers with rank of Brigadier-General, 12 Colonels, 19 Lieutenant-Colonels, 39 Majors, 51 Captains, 47 First-Lieutenants and 19 Second-Lieutenants. All told, 118 men. Numerically, not enough to conduct the engineering operations of the Pennsylvania R.R.

Of these, 11 are engaged in building the Panama Canal, two are in the Philippines, one in Hawaii and 14 are detailed as instructors at West Point and other training schools. This leaves 90 men to cope with all the engineering requirements of the United States and its territorial possessions, an aggregate area of 3,742,583 sq.m. with a coast line of 48,881 miles and a navigable river system in the United States proper of 26,410 miles.

With 75,000 sq.m. of swamp land to be drained and protected, and 1,200,000 sq.m. of arid lands to be reclaimed by irrigation, my argument for a National Department of Public Works rests upon the facts recited. For lack of such a department some of the gravest problems confronting our fullest material development and welfare of our people have gone too long unsolved.

[The proposition for a U. S. Department of Public Works, headed by a cabinet officer, as put forward by Mr. Randolph was embodied in a resolution presented to and adopted by the National Drainage Congress. In this resolution no attempt was made to outline the organization of such a department, but a proposed bill accompanying the paper quoted above set forth that the Secretary of Public Works (to be appointed by the President) should appoint a Commissioner of Public Works who should be an engineer of recognized ability and experience. The purposes of the department would be as follows: 1, to carry out all constructive works, such as public buildings, levees, dams, roads, bridges, etc., authorized by Congress; 2, to secure physical data as to rivers, swamps and arid regions, to make topographical surveys, and to study meteorological data with a view to determining flood expectancy; 3, to select sites for flood-water reservoirs and water-power development, and to study problems of drainage and irrigation. It should consider first works whose importance or necessity has been demonstrated by disasters.—Editor.]

*Extract from an address before the National Drainage Congress at St. Louis, Mo., April 10. Mr. Randolph's suggestion was embodied in a resolution adopted at the meeting, as noted at the end of this article.

†Consulting Engineer, Chicago.

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The Status of the Engineer

At the meeting of the American Institute of Consulting Engineers on Mar. 11 the subject of the professional relation of the engineer, which was considered at the January meeting, was further discussed. Following are brief extracts from the remarks of the various speakers:

LINCOLN BUSH—If the engineer be required to limit himself to purely professional functions with elimination from commercial problems, he will fall far short of that great usefulness which his education and efforts would otherwise accomplish. Good engineering, from the inception and design of work through to its finish and on to its management, has opened up a decidedly greater and broader field for the engineer than has ever existed heretofore. While engineering as a profession may in time be overshadowed by this broader field, the engineer will never cease to exist. If engineering becomes more of a commercial asset, I believe the engineer and the community will be better off for it. The measure of an engineer's qualifications for better remuneration and position is gaged by his ability to accomplish efficient, economical results. I am not in favor of bolstering him up by any license system or legal enactment. Such legislation should be for the protection of the weak and the restraint of the unscrupulous. Neither of these conditions apply to the engineering profession.

J. E. GREINER—It seems to me that the laudatory phrases of engineering indulged in by lecturers and professors to inspire enthusiasm in engineering students indicate that their optimistic authors see the ring of the doughnut but not the hole, while the pessimistic engineers who believe we are doomed as professional men see only the hole in the doughnut and not the ring. If we set off one side against the other we will have a middle course. The engineer is neither a co-partner with the gods nor a member of a skilled trade; but the real engineer is an educated and experienced man, above all endowed with good

common sense. The man who is practicing engineering in the sense which real engineers understand the term is beyond question a professional man.

There are a large number of people who call themselves engineers simply because they may have had engineering schooling and because they may have held a leveling rod, or inspected materials, or maybe made detailed drawings for engineers. Again, there are a large number of men who were educated as engineers but who are simply salesmen. Others have gone into corporation management and all kinds of industrial business. Many of these men may be engineers and good ones, but they are not practicing engineering. They abandoned this to become business men.

Neither are inspectors, draftsmen, country surveyors, chainmen, rodmen and levelers on an engineering corps in the practice of engineering. They are simply on the outer borders, doing work connected with engineering. Those in such occupations are not necessarily engineers, though there is nothing to prevent them assuming the title if they so desire.

It seems to me that instead of the engineering profession being on the down grade, it is on the up grade; and if it is passing through a transition period, the transition will simply mean the separation of the professional from the commercial engineer.

It still remains for the national engineering societies or our own Institute to adopt regulations which will establish a man's standing either as a professional or a commercial engineer. Our own Institute is limited to independent or consulting engineers. Some other Institute will have to take care of those other professional engineers who are not in independent practice, but who are just as much professional engineers as any member of this Institute. Whether the licensing of engineers will be the solution of the question or not, I am not prepared to say, but I would be in favor of an association which would have full legal authority to determine who shall and who shall not be entitled to practice as engineers.

EUGENE W. STERN—I do not believe that the consulting engineer in connection with building construction is any more the middle man who should be eliminated than that the architect is the middle man, the one being just as necessary as the other. Some, who call themselves consulting engineers, prepare only the design and then throw all the responsibility of the execution of the work on the architect. The service they thus give is no more than that which a draftsman with a knowledge of design in that particular question could give, and the rendering of such perfunctory service has unfortunately lowered the status of the engineering specialist in the minds of many prominent members in the architectural profession and even among contractors.

The conscientious architect will see to it that the client's interests are properly safeguarded by himself employing competent specialists, but in far too many cases this it not done and the client's interests suffer, for either the specialist's work is indifferently done in the architect's office or he employs so called specialists, or calls on the contractor to loan him the services of his engineer.

An architect is doing his client's interests grave injustice when he allows himself to be under such obligations to the contractor. Furthermore, he is placing the contractor's engineer in a false and difficult position when he asks him to serve two masters.

A firm of well known contractors made the structural design for a large building for an architectural firm which was so obviously padded with unnecessary metal that after the plans had been issued for bids suspicion was aroused and I was called in to check over the work. A new set of plans were made and a saving effected of between $40,000 and $50,000, almost 10% of the total cost of the work.

I feel that I am making a perfectly safe statement when I say that were the loss of life and property and waste of material which occurs in reinforced-concrete and steel construction in this country annually capitalized it would pay the fees of all the competent consulting engineers in this country one hundred fold.

S. WHINERY—The great majority of the reputable engineers of the country will welcome a project for the official recognition of the profession of engineering and for the reasonable regulation of professional engineering practice. Any such scheme should be broad enough to embrace all the different branches of professional engineers; it should provide for the largest degree of control within the profession itself of practical measures and methods for regulating professional organization, conduct and practice. There should be a minimum of statutory enactments and a maximum of administrative authority within and by the profession. In short, the state law should permit a large measure of what may be called the home rule in the profession.

Such a proposed law might create a state board of, say, five members to be appointed by the governor in the following manner: Each of the four great national engineering societies would nominate three men from among whom the governor would select and appoint one member of the board, the fifth member to be selected by the governor upon his own initiative. This board should be empowered by law to exercise general supervision and control over the professional practice of engineering.

The board would divide the whole field of engineering into such branches, and these branches into such subdivisions or grades as deemed necessary. Applicants for registry would be examined in one or more of these branches and certificates issued accordingly. Thus, a civil engineer might be registered to practice either one or several specialties, or in the grade of junior engineer, assistant engineer, senior engineer, or consulting engineer.

The board would be empowered to formulate codes of ethical conduct for the control of engineering practice and the protection of the public and to cause the arrest and prosecution of persons practicing the profession without authority or transgressing the ethical codes. Such a scheme would establish the profession of engineering upon a well defined basis and give it a character and standing with the public that is impossible under present conditions.

It might reasonably be expected that if a wide, comprehensive scheme of this kind were worked out and applied in a great state like New York, other states would from time to time adopt practically identical measures.

L. C. HOLDEN—Perhaps the greatest difficulty that presents itself to engineers in their ambition to establish themselves as a purely professional body is the absolute need of engineering draftsmen by the great manufacturing and contracting concerns. A young man graduates from a technical school and finds himself thrown upon the world with the necessity of self-support. He follows the line of least resistance and becomes a corporation employee with the expectation and hope that conditions will change and enable him to practice his profession individually. In the great majority of cases these men become settled and dependent upon their positions, lose courage and initiative, and allow themselves to be used in any capacity desirable from their employer's standpoint. They cease to become engineers as they hoped to be and are draftsmen or salesmen. When one thinks of the vast interests that are operating under these conditions, it makes the fight of the professional engineer apper one of great difficulty.

OWEN BRAINARD—A law is pending in New York for the registration of architects. Personally, I am not in accord with this proposition and I am quite positive that any similar law for the registration of engineers or the licensing of them would not help you in the general effort to protect the profession and the public from incompetent men.

I suggest that it may be possible to secure better protection for the profession and the public by some sort of control through the official scrutiny of design, as we have in municipal work in building inspection. I have felt for some time that the design for a bridge or for foundations for any structure should be scrutinized either by a municipal bureau or a state bureau.

ALLEN HAZEN—I have felt very strongly about this matter of state control. If the state licenses every engineer, then every man who performs some useful function in the profession, however small, is entitled to recognition and to license. No one can be refused. Thus the way will be open for men of small experience who are licensed to use their license as a means of getting important business that they may not be qualified to handle.

GUSTAV LINDENTHAL—Concerning registration and licensing, I share the opinion of Mr. Hazen, that it would do more harm than good. You will have to let anyone in. You cannot exclude anyone without giving a good reason and the country surveyor cannot be rejected, because he is a man who is highly regarded by his neighbors.

This is a time of transition in the engineering profession. We have overlooked the relation of the beginner to the master. Everybody wants to be the master. There is a feeling that one man is as good as another. Why should he not be if he has passed through an engineering school?

I do not think relief lies in the direction of legislation. Things will settle down eventually to a more stable condition, but it will not be by legislation or the aid of Regents or titles, but it will be by standing together and a small number can do that better than a large number. It is well known that the large engineering societies shun the question of the status of the engineering profession for fear of offending members.

The Derailment of an Excursion Train on the Montreal-Chambly branch of Central Vermont Ry., about 4½ miles from St. Lambert, Que., resulted in the deaths of seven persons on Apr. 13. The telescoping of the ends of the derailed coaches is reported to have been the cause of most of the fatalities. The train was crowded and many passengers were riding on the platforms.

The Derailment of an Electric Car on a pile trestle across the Patapsco River at Baltimore, Md., caused the death of one passenger and injuries to 25 others on Apr. 8. The trestle was about 12 ft. high and the water but 4½ ft. deep so that most of the passengers were able to escape with slight injuries.

An Express Passenger Train Was Wrecked by a Snowdrift on the Union Pacific R.R., 2½ miles west of Cheyenne Wells, Colo., on Apr. 10. The train, known as the St. Louis-Colorado Limited, was drawn by two large locomotives. The wreck is said to have been due to the striking of a drift of heavy snow while the train was moving at about 20 miles per hour; the pilot of the leading engine was torn loose and fell under the forward trucks, throwing the locomotive over on its side. The second locomotive was also overturned and thrown about 30 ft. to one side of the track. The first three cars were derailed but remained upright. The driver of the second locomotive was killed and several mail clerks and passengers more or less injured.

A Premature Explosion of Dynamite being used to fill some 90 drill holes in the excavation between the Miraflores and Pedro Miguel Locks, Panama Canal, caused the deaths of 3 laborers and injuries to 23 others on Apr. 19, according to press dispatches. Reports state that the accident occurred in the afternoon after about 21,000 lb. of the explosive had been placed in the drill holes and warning was about to be given the workmen to retire to a safe distance.

The Explosion of the French Army Balloon "Zodiac," near Noisy-le-Grande, on Apr. 17, caused the deaths of four army officers and a civilian. According to newspaper reports the five occupants of the car were considerably shaken up before the explosion occurred, for the car had been thrown successively against a chimney, a house and some telegraph wires.

The Explosion of an Ammonia Tank at one of the plants of the Moore Ice Co., Pensacola, Fla., caused the death of four men on Apr. 10. The tank is said to have contained approximately 2000 gal. of ammonia.

Steel Sheet-Piling for use in emergency protection of Mississippi River levees, has been furnished to the amount of 450 tons. The Carnegie Steel Co. received an order at its Pittsburgh office on the night of Apr. 7, for 1250 pieces of sheet-steel piling. As not all of this material was in stock, the beam department put on every available man to facilitate the rolling of the order, and it was loaded on twelve cars at noon, Apr. 10. A special train left Pittsburgh at 5:13 p.m. the same day, and because of washouts was detoured through West Virginia, arriving in Cincinnati at 8:19 a.m., Apr. 12. The shipment reached New Orleans at 3:15 a.m., Apr. 14, and is now being driven.

The State Department of Efficiency and Economy of New York, referred to in our editorial columns of Feb. 20, has been provided for in a bill signed by Governor Sulzer on Apr. 15. The New York "Times," of Apr. 16, quotes the Governor as saying that his Commission of Inquiry has "fully demonstrated that the business and the financial affairs of the state have been conducted without system, extravagantly, and with divided responsibility, in a manner which would bring bankruptcy and ruin to any business not having the resources of the state." A commissioner of the new department is to be appointed by the Governor at a salary of $12,000 per annum, for a term of five years. The commissioner is to have the power to investigate any other state department having to do with the business methods of the government. The commissioner is to report to the Governor and to the heads of the departments plans for improvement in the administration of their offices. The commissioner is empowered to appoint his necessary assistants and to fix their salaries.

Another bill the Governor signed on the same day creates a State Board of Estimate, the duties of which are similar to New York City's Board of Estimate and Apportionment. It is to prepare the annual budget for submission to the Legislature. The board will be composed of the Governor, Lieutenant-Governor, President pro tem of the Senate, Chairman of the Senate Finance Committee, the Speaker of the Assembly, the Chairman of the Assembly Ways and Means Committee, the Controller, the Attorney General and the Commissioner of Efficiency and Economy.

The Bill Giving the Minnesota State Board of Health supervision of water-supplies and sewage disposal, commented on editorially in our issue of Mar. 27, 1913, has been withdrawn from the legislature by H. H. Harrison, of Stillwater, the introducer of the bill. We are not informed as to the reason for its withdrawal, but assume that it was because of so much opposition that the bill seemed certain of failure. Apropos of our suggestion in the editorial named that the support of the local engineering societies at St. Paul and Minneapolis might have been or might be secured for the bill, we have been informed that some two years ago the bill, or one substantially like it, was taken up in conference with a committee of the Engineers Society of St. Paul, which committee made no objection to the bill. It was also laid before members of the Engineers Society of Minneapolis, who did not see fit to support the bill. We are also informed that the bill and our editorial comments upon it were scheduled for discussion before the Engineers Society of St. Paul on Apr. 14—the program very likely having been arranged before the withdrawal of the bill from the legislature.

The Commission Plan of City Government was adopted at Jersey City, N. J., on Apr. 15, by a vote of 11,422 for to 7116 against, giving a majority of 4306. On the same date Bayonne and three other New Jersey cities in Hudson County voted against the plan. Bayonne defeated the plan by a majority of 295; Hoboken by a majority of 403, and Union Hill by a majority of 824. Candidates for the five commissionerships at Jersey City will be nominated at a primary to be held on May 13 and the election will be held on June 10 following. In 1911 the Commission Plan was defeated at Jersey City by a vote of 13,068 to 11,585. The adverse vote in 1911 was slightly less than the favorable vote in 1913, but the adverse vote this year dwindled considerably.

Seventeen Amendments to the Charter of Los Angeles, Calif., were passed on by popular vote on Ma. 24, and all but five were carried. Of the four defeated amendments one was designed to make the park commission largely independent of the city council, one provided for a return to ward representation, with 15 ward councilmen and 6 elected at large, in place of the present 9 at large, and one fixed the salaries of councilmen so elected. Another defeated amendment would have created an electric harbor board, largely independent of all other city officials, and with power to grant 40-year franchises. In opposition to this harbor-board amendment one was carried which provides for three harbor commissioners, appointed by the city council, and with franchise safeguards in the interests of the people; and with a provision that no single person or corporation should be granted more than 3000 ft. water frontage unless the grant be authorized by a referendum vote, and even then the limit is to be 5000 ft. Other amendments enlarge the city's municipal ownership powers and permit the city to exercise any power within the right of any other California city "and to engage in any business that may be specifically authorized by a vote of the electors"; limit all franchises to 21 years, except that under certain conditions subways and elevated railroads may be given 40-year franchises, with possible 10-year extensions; give the city council ordinance control over all appointive boards and officers except the civil service commission, and charge each councilman to keep posted on one of nine branches of the city business, but with no administrative powers; require daily sessions of the council and fix the salary of the mayor at $4500 a year and the other councilman at $2400 each; call for a new election of mayor and councilmen in June of this year; and abolishes the "Los Angeles Municipal Newspaper."

The City of Chicago's Share of Street-Railway Profits for 1912, is reported to be $2,500,992, which is $635,648 more than it received in 1911, and in excess of any year's apportionment during the six years the present ordinance has been in force. The total amount which the city has so far received, including the present year's allowance, is $10,334,200 which, with accrued interest of some $400,000, makes the city's special traction fund now approximately $10,730,000.

The Chicago settlement ordinances were described in "Engineering News," Mar. 10, 1910, and Sept. 19, 1912. It will be remembered that the companies are allowed 5% on an agreed book valuation of their property, after their operating expenses (including maintenance, renewals, accidents reserves and taxes) have been paid. Then the net return is divided, 55% going to the city and 45% to the companies. The city's share is placed in a fund for the purchase and construction of railways.

An Unusual Amount of Typhoid Fever at Zanesville, Ohio, has been reported since the recent floods in that city. The following information has been kindly supplied to us by W. H. Dittoe, Chief Engineer of the Ohio State Board of Health, un-

der date of April 17: During the past three weeks 27 cases of typhoid fever have been reported at Zanesville. It is believed that not all cases have been reported. Most of these reports have been received since the floods. Even the number reported is larger than the normal for the city. Regardless of flood conditions, the water-supply at Zanesville is of such unsatisfactory quality as to cause a rather steady high typhoid rate. A plant for treating the water-supply, which is drawn from the Muskingum River, was nearly ready for operation on Apr. 17. It will consist of a dissolving tank and three 1200-gal. solution tanks, connected with a constant-head orifice feed tank. The solution will be discharged from the feed tank through a grid into the suction well of the pumps. The plant will be capable of treating as much as 11,000,000 gal. per day. The provisional rate of treatment will be 25 lb. of bleaching powder per 1,000,000 gal., or one part per million available chlorine.

Flood Flows in New York State during the month of March, 1913, established new high records at many points. The following table gives preliminary results of the maximum discharge at various points determined by the Water Resources Branch of the U. S. Geological Survey:

Station	Max. discharge	Drainage area	Sec.-ft., sq.mi.
Hudson, Spier Falls	100,000	2,800	35.8
Hudson, North Creek	28,200	804	35.1
Sacandaga, Hadley	29,000	1,060	27.4
Cattaraugus, Versailles	25,000	467	53.6
Genesee, Rochester	50,000	2,360	21.2
Genesee, Jones' Bridge	17,700	1,410	12.6
Salmon, Pulaski	10,800	260	41.6
Ausable, Ausable Forks	22,000	487	45.2
Chemung, Chemung	52,500	2,440	21.5

Levels are now being run by U. S. Geological Survey to determine the elevation of the crest of floods at the various gaging stations.

The Flood in the Mississippi is passing down the river at a slightly higher stage than the record flood of 1912, but so far the levee breaks have been comparatively few and the damage by overflow slight. On Apr. 21, the stage at Natchez, Miss., well below the flood crest, was 51.6 on a rising river. The previous high water there was 51.4 in 1912.

Motor Vehicle Accidents resulted in 967 deaths in New York State in the two years 1911 and 1912, according to the report made by the Secretary of State to Governor Sulzer on Apr. 19. Besides this number killed, 6107 persons were reported seriously injured. In the Borough of Manhattan, New York City, alone, 585 persons have been killed outright and 4068 seriously injured since 1911.

Eight Proposed Los Angeles Bond Issues totaling some $12,000,000, were subjected to popular vote on Apr. 15. Only two issues were carried: $1,500,000 for a pipe line from the end of the Los Angeles Aqueduct to the city and $2,500,000 for harbor improvements. The defeated issues were for conduits to carry the surplus waters of the Los Angeles Aqueduct for sale for irrigation purposes (see long article in our issue of Mar. 13, 1913); for distribution of electric current generated by the aqueduct hydro-electric plant; for a municipal railway at the harbor; for a city hall and for buying a piece of land for municipal purposes. The power bonds had a heavy actual majority, but it was just under the legal two-thirds. The other issues that failed were badly beaten.

Two Very Large Steamships for the transatlantic trade were launched during the past fortnight. The "Vaterland," hitherto announced as the "Europa," of the Hamburg-American line, was launched on Apr. 3 at Hamburg, and the "Aquitania" of the Cunard line, was launched at Glasgow on Apr. 21. These two ships are to be the largest vessels in the world and, with the Hamburg-American liner "Imperator," which is due to reach New York on her maiden voyage some time in May or June of this year, will be the only vessels over 900 ft. in length entering New York harbor. It will be remembered that the present agitation in New York for 1000-ft. piers is based entirely on the coming of these vessels.

Below is given a tabular statement of the dimensions of these three ships, the White Star liner "Olympic," the present largest ship in service, and the "Mauretania," only recently the record holder

Ship	Gross tonnage	Length, ft.	Breadth, ft.	Date
"Mauretania"	32,000	760	88	1907
"Olympic"	45,000	883	92	1911
"Imperator"	50,000	900	96½	1913
"Aquitania"	50,000	901	97	Building
"Vaterland"	50,000 +	950	100	Building

The Cunard liners "Mauretania" and "Aquitania" are much faster than any of the other three ships noted in the table.

PERSONALS

Dr. Willis L. Moore, Chief of the United States Weather Bureau, has been removed by President Wilson

Mr. H. F. Porter, Jun. Am. Soc. C. E., and a graduate in civil engineering of Cornell University, Class of 1905, has been elected Alderman in Chicago, Ill.

Mr. Julian Griggs, M. Am. Soc. C. E., formerly Chief Engineer of the Lancaster Traction & Power Co., Columbus, Ohio, has been made City Engineer of Lancaster, Ohio.

Mr. Ira L. Burlingame, for several years General Superintendent of the Terminal Railroad Association of St. Louis, Mo., has been promoted to be General Manager.

Mr. Paul D. Cook, Assoc. M. Am. Soc. C. E., announces that he has opened an office for general practice as a consulting engineer, with offices at 513 United Bank Bldg., Sioux City, Iowa.

Mr. F. M. Bisbee, M. Am. Soc. C. E., Engineer of the Western Lines of the Atchison, Topeka & Santa Fé Ry., at La Junta, Colo., has been promoted to be Chief Engineer of the Western Lines.

Mr. S. W. Greenland, Assoc. Am. Inst. E. E., Assistant General Manager and Purchasing Agent of the Fort Wayne & Northern Indiana Traction Co., has been promoted to be General Manager.

Mr. Henri Camp, Civil Engineer, has been appointed Secretary of the International Association of Tramways and Light Railways, with offices at Brussels, Belgium. He succeeds the late Paul t'Serstevens.

Mr. W. R. Roof has been appointed Engineer of Bridges and Buildings of the Chicago Great Western R.R., with headquarters at Chicago, Ill., succeeding Mr. C. Chandler, resigned, as noted elsewhere.

Mr. C. E. Douglas, formerly Special Engineer in charge of construction and betterments of the Northwestern Pennsylvania Railway Co., Meadville, Penn., has been promoted to be Chief Engineer of the track and roadway department.

Mr. Thomas W. Walsh, formerly Assistant Superintendent of the Oregon-Washington R.R. & Navigation Co., at Spokane, Wash., has been promoted to be Superintendent of the newly created division with headquarters at La Grande, Ore.

Mr. A. M. Hunt, M. Am. Soc. M. E., Consulting Engineer, San Francisco, Calif., has been appointed Chief of the department of machinery of the Panama-Pacific International Exposition. Mr. G. W. Danforth is Assistant Chief of the department.

Mr. Hugh Wilson, Assistant Superintendent of the Northwestern Pacific R.R., has resigned to become Inspector for the California State Railroad Commission. Mr. Wilson graduated in civil engineering from the University of Nebraska and was at one time Assistant Engineer on the Missouri Pacific Ry.

Mr. Waldo Arnold Layman, F. Am. Inst. E. E., President and General Manager of the Wagner Electric Co., St. Louis, Mo., has been elected President of the National Metal Trades Association. Mr. Layman graduated from Rose Polytechnic Institute in 1892, and has been with the Wagner Electric Co. ever since.

Mr. L. B. Wickersham has been appointed Chief Electrical Engineer of the Oregon Electric Ry. and the United Rys., Portland, Ore. The other engineering duties of Mr. Wickersham, who has hitherto been Chief Engineer, will be assumed by Mr. A. M. Lupfer, M. Am. Soc. C. E., Chief Engineer of the Spokane, Portland & Seattle, the Oregon Trunk and the Spokane & Inland Empire Rys.

Mr. R. A. Rutledge, formerly Assistant Chief Engineer of the Gulf, Colorado & Santa Fé Ry., at Galveston, Tex., has been promoted to be Chief Engineer of the Eastern Lines of the Atchison, Topeka & Santa Fé Ry. System, with headquarters at Topeka, Kan., succeeding Mr. C. F. W. Felt, M. Am. Soc. C. E., whose appointment as Chief Engineer of the entire Santa Fé System was announced in our columns of Apr. 3.

Governor S. M. Ralston, of Indiana, has appointed the following members of the newly created State Public Utility Commission: Mr. Thomas Duncan, of Princeton, Ind., a former attorney of the Southern Ry.; Mr. James L. Clark, of Danville, Ind., a former attorney of the New York Central Lines; Mr. Charles J. Murphy, a land owner and stock raiser, of Brookston, Ind., who graduated in civil engineering from Purdue University in 1893; Mr. John F. McClure and Mr.